SCIENCE

VOL. 92 FRIDAY, NOVEMBER 1, 1940 No. 2392

Science Five Thousand Years Hence: DR. ALBERT F. BLAKESLEE 387
The Value of the Fundamental Sciences in the Establishment of Anesthesiology: DR. JOHN S. LUNDY 388
Obituary:
Phoebus Aaron Theodor Levene: DR. LAWRENCE W. BASS 392
Scientific Events:
Engineering Education at the Rensselaer Polytechnic Institute; Extension Courses in Aeronautical Engineering of Cornell University; Fellowships in the Medical Sciences of the National Research Council; The Midwest Wildlife Conference; Award of the William H. Nichols Medal of the New York Section of the American Chemical Society 395
Scientific Notes and News 397
Discussion:
Multisensual Mathematical Terms: PROFESSOR G. A. MILLER. *Holly Defoliation Prevented by a-Naphthaleneacetic Acid:* DR. J. A. MILBRATH and PROFESSOR HENRY HARTMAN. *Oncoming Reversal of the Human Growth Tide:* DR. C. A. MILLS. *Wider Use for Academy of Science Publications through Improved Distribution:* DR. C. F. STEWART SHARPE 400
Societies and Meetings:
The Tucson Meeting of the Southwestern Division of the American Association for the Advancement of Science: DR. FRANK E. E. GERMANN 403
Special Articles:
A New Type of Virus from Epidemic Influenza: DR. THOMAS FRANCIS, JR. *The Vibration of Circular Plates:* PROFESSOR R. C. COLWELL, J. K. STEWART and H. D. ARNETT 405
Scientific Apparatus and Laboratory Methods:
A Method for Measuring and Recording Continuously the pH of the Circulating Blood: PROFESSOR C. E. KING and DR. EDMUND W. BENZ. *A Simple Inexpensive Device for Accurate Delivery of Small Amounts of Fluid:* JOSEPH VONDRAK 409
Science News 8

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.
New York City: Grand Central Terminal
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

SCIENCE FIVE THOUSAND YEARS HENCE[1]

By Dr. ALBERT F. BLAKESLEE

DIRECTOR, THE DEPARTMENT OF GENETICS, CARNEGIE INSTITUTION OF WASHINGTON AT COLD SPRING HARBOR, L. I., N. Y.; PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

I HAVE been asked to predict the condition of science five thousand years hence when the Time Capsule is dug out of the Flushing meadows—provided there are any meadows here in A.D. 6939. Land has been rising and falling in different parts of the globe within historic time, and within five thousand years the Time Capsule may be considerably below sea level or raised several hundred feet above where it is now.

While I speak *to* the youth of to-day, I am speaking *for* the youth that will be living one hundred and fifty generations hereafter, in other words to your great, great, one hundred and fifty times great grandchildren.

[1] Address before the American Institute of the City of New York at the World's Fair, September 23, in connection with the sealing-in of the Westinghouse Time Capsule. The address was broadcast in part over the NBC network.

One can predict only in terms of what is known in the past. Let us compare what has actually occurred within these fifty centuries with what a man five thousand years ago might have predicted for the present. He could not have thought about development of world civilization because the world to him was only a limited region. Civilizations could develop and decline with little or no influence on one another because of lack of means of communication. His knowledge of the geographical world and of the laws of nature was so limited that it would have been impossible for him to predict the condition of the world in 1940. Science, as we understand this term, did not exist in B.C. 3060.

Are we to-day in our ignorance as incapable of predicting the future five thousand years hence as was the man five thousand years ago? In many ways probably yes; in other ways we have an advantage.

We have made a start. So far as his physical and his mental equipment are concerned, I see no evidence that man to-day is better than five thousand years ago. He does, however, have better tools—by tools I include the methods of science as well as the actual instruments, such as the microscope, which enable him to delve deeper into the unknown and learn the laws of nature. The development of science seems to act like a falling body in that, once started, its speed is enormously accelerated with time. There is an interrelation of science such that each new tool or method makes possible newer tools and further discoveries. In many branches, and perhaps in science as a whole, more progress has been made within the life span of a single man than in all time before.

Last week I had the privilege of taking part in the celebration of the bicentennial of the founding of the University of Pennsylvania by Benjamin Franklin. Two hundred years is not a long time so far as the recorded history of mankind is concerned. It is only a one-twenty-fifth part of the period of time we are discussing to-day. Two hundred years is a long time, however, in the history of my own field of biological research. In 1740 Benjamin Franklin and the other founding fathers of the University of Pennsylvania knew little about biology for the simple reason that biology at that time was an almost undeveloped subject. An adequate system of naming plants and animals was lacking, and it was only thirteen years later, in 1753, that Linnaeus published his "Species Plantarum" and introduced to the world the binomial system of classification which has been used ever since for the names of both plants and animals. Few of the titles of the biological papers which were given at last week's celebration in Philadelphia could have had any meaning to Franklin and his colleagues because such words as *germ plasm, chromosomes* and *genes* were not in use till more than a century after Franklin's time.

A couple of years ago at the Richmond meeting of the American Association for the Advancement of Science there was celebrated the one-hundredth anniversary of the cell theory. The newness of our knowledge of cells is evident when we realize that more than two thirds of the last century's study of cells is covered by the life span of one of the speakers on the program of the Pennsylvania Bicentennial. Chromosomes were discovered in 1873 when he was three years old and were given the name of chromosomes in 1888, when he was an eighteen-year-old freshman in Kansas University. An example from my own special field of genetics is the fact that knowledge of the mechanisms of heredity has been developed entirely within the last forty years. Progress was slow at first but has become increasingly rapid until now we feel justified in predicting the conscious control of the evolution of plants, animals and even of man himself. Thus in addition to having more and better tools, man, five thousand years hence, may be a better creature physically, mentally and morally.

Detailed prophecies, of course, are impossible. We can only guess at trends. The psalmist said, "Oh! had I wings like a dove, for then I would fly away and be at rest." Many doubtless have had the same desire to fly. Leonardo da Vinci less than five hundred years ago drew plans of a flying apparatus. It was only, however, after the invention of the internal combustion engine that flying became an accomplished fact. This was the outcome of centuries of yearning. We make progress in learning by yearning. If we study what the things are which mankind yearns for, we may be sure that these will be things in which progress will have been made five thousand years from now.

We have yearned not only for wings, which we have now acquired, but also that we may fly away and be at peace. I believe within five thousand years man will have made progress in satisfying this yearning; whether by changing his environment through improvements in social organization or through changing the nature of man, we can not foretell. I believe progress is due in knowledge of how man may live in harmony and at peace in large as well as in small groups. I believe that governments will depend increasingly on expert knowledge—that we shall seek information before legislation rather than the reverse. I believe that by the scientific method we shall more effectively seek the truth and that the truth shall make us free.

THE VALUE OF THE FUNDAMENTAL SCIENCES IN THE ESTABLISHMENT OF ANESTHESIOLOGY[1]

By Dr. JOHN S. LUNDY

SECTION ON ANESTHESIA, THE MAYO CLINIC, ROCHESTER, MINNESOTA

THIS seems to be a suitable occasion for an individual who has had an opportunity to participate in the development of anesthesiology,[2] a new specialty in medicine, to call your attention to the fact that the fundamental sciences are the outstanding factors in

[1] Read before the meeting of the North Dakota Academy of Science, Fargo, North Dakota, April 26, 1940.

[2] J. S. Lundy, E. B. Tuohy, R. C. Adams, L. H. Mousel and T. H. Seldon, *Proc. Staff Meet., Mayo Clin.*, 15: 241–254, 1940.

the further development of this specialty. For a great many years anesthesia was largely an art, but now it is developing also into a science and into a major specialty of medicine. This progress has been recognized with the establishment of an Examining Board in Anesthesiology for the purpose of certifying those physicians who are considered to be competent to specialize in that type of medical practice. The American College of Surgeons and the American Medical Association both recognize this board and are advised by it in regard to certain surveys of anesthesia services that are made throughout the nation in the various hospitals. The rating of the hospitals in respect to anesthesia depends on how well they are supplied with anesthetic agents, what methods of anesthesia they are equipped to use, what library facilities in anesthesia they possess and what personnel trained in anesthesia they employ. Certain of the institutions do not attempt to teach, while others are considered to be satisfactory places for men to take training. At the New York World's Fair it was noted that more than 1,000,000 people interested themselves in the exhibit on anesthesia which was there.

There are societies of anesthetists and there are publications devoted to anesthesiology. I have had a hand in the development of one of them, *Anesthesia Abstracts*. The idea underlying this publication was obtained from *Chemical Abstracts; Botanical Abstracts, Physiological Reviews* and other magazines of a type which have been found very valuable to workers in the fundamental sciences. It seemed to me that a periodical of similar type should be equally valuable to those engaged in a specialty of clinical practice; happily for me the reception accorded this periodical justified my assumption.

In the effort to outline the development of the scientific side of anesthesiology, it is worth while to point out some of the incidents that illustrate the interrelation of the anesthetist and the scientist. The relationship of art and science in the development of a specialty was well stated by Jevons who said, "Science teaches us to know and an art to do."

The history of anesthesia dates back to the time of Herodotus, when concoctions of hemp and mandragora were used to stupefy the sensibilities of individuals who must undergo pain. It is said that even the ancient Chinese used opium to mitigate the horrors to which condemned criminals were subjected in order that the people, ignorant of the insensibility of the victims, might be impressed by the punishment, while those who enforced the law would not hesitate to carry out the sentences. In more recent years Henry Hickman, a young British physician who attempted to work in the field of relief of pain, carried out many experiments with various substances, among them carbon dioxide, but he died an early death filled with disappointment because of lack of sympathetic help and understanding from others. Another young British physician, John Snow, did pioneer work (1850) in the scientific study of ether, use of which for anesthesia had been made known by the dentist, William Morton of Boston. Both of these men died in disappointment, both when they were less than fifty years of age. Horace Wells, dentist of Hartford, Connecticut, introduced nitrous oxide as an anesthetic agent in 1844 and he ended his life shortly thereafter without having received the support of the dental or medical professions. Crawford Long of Georgia used ether in 1842, and for this he was harassed by the inhabitants of his community. Sir James Simpson of Scotland, who introduced chloroform, was persecuted by the people and only overcame their objections through royal favor. Very recently Howard Jones introduced a method of spinal anesthesia and, because of unfavorable criticism and non-support of his efforts, committed suicide. The lives of these men represent some of the unhappiness that has surrounded the development of the specialty of anesthesiology and serve as examples of the hindrances to the development of any specialty if support is withheld. Fortunately, there is a happier side to the story and it is that about which I would like to speak.

In the last twenty years opportunities have been made available to certain physicians throughout the United States and Canada, who are interested in the administration of anesthetic agents, to put into practice ideas that have come to them both in regard to clinical practice and to research. These individuals have become known and, as a result, drugs have been presented to them for investigation. When a new method of anesthesia has been devised these investigators usually have had a part in furthering its clinical application. Many a scientist has advised and cooperated with them in institutions of higher learning and they also have cooperated with scientists who are engaged in the development of new commercial products that are useful to the anesthetist. As a result, to-day training in anesthesiology is available in several places and more positions are available in this field than there are trained persons to fill them. This situation probably will continue to exist for at least the next fifteen or twenty years. It is, I believe, a pleasant thing to contemplate that opportunities do exist for young people in this field and that coexistent with those opportunities are many opportunities for contributions to the relief of human suffering. This situation will continue to exist, however, only if those engaged in work in the fundamental sciences will continue to cooperate in the future as they are doing at present. Therefore, if there are in this audience those

who wish to investigate phases of anesthesiology which might well prove interesting to them, they will find the anesthetist eager to discuss the problems that face him and, in turn, to furnish his share of cooperation.

I believe I can best illustrate some of the benefits of this cooperative effort by citing certain happenings of the past. Let us take at random a few of the sciences that are represented in this room and mention some of the contributions they have made to anesthesiology; we can not attempt to enumerate the contributions of all the sciences. The science of anatomy is of fundamental importance to all branches of medicine, including that which includes the anesthetist. Often he must deposit a local anesthetic agent near a given portion of a certain nerve trunk for purposes of producing anesthesia for operation or for diagnosis or for purposes of therapy. To know the location of blood vessels is important so that they may be avoided or entered accurately, as the occasion may require. Knowledge of the bony landmarks is essential in the localization of nerves and vessels. The anatomy of the respiratory passages is necessary knowledge to him who would administer anesthetic substances by inhalation. To know the anatomy of the colon is useful when anesthetic agents are to be administered by bowel. An anatomist's contribution that at first would seem to have to do only with his own science is the work of Clark, of Philadelphia, who devised a means of observing capillaries through an artificial window in a rabbit's ear. This device had been in use for thirty years when, about a year and a half ago, T. H. Seldon[3] began to utilize it for investigation of the effects of certain anesthetics on the capillaries. Much valuable information may be obtained from this application of Clark's investigation of capillaries, for it is not easy to find test objects that will give reliable information.

The work of Rosenow and Tovell,[4] in studying the cause of convulsions under general anesthesia has provided a possible solution of the problem through bacteriology. In the field of botany and horticulture, Knight, working with Crocker,[5] discovered that the ethylene portion of illuminating gas would put carnations to sleep. This information was related to Luckhardt,[6] the physiologist, who tried the gas on mice and then on himself and his other laboratory workers. Attention was called to it as an anesthetic agent for clinical use and it was administered by Dr. Isabella Herb in clinical practice at Presbyterian Hospital in Chicago. Recently when the supply of ephedrine was reduced because of the war in China, the plant Mahjung was cultivated in Brookings, South Dakota, thus showing how anesthetists may keep themselves supplied with this valuable stimulant to the cardiovascular system.

The contributions of chemistry have been of great value. Without them, much of the rapid development in the use of new anesthetic agents and certain other drugs would not have been accomplished. The isolation or manufacture of oxygen, nitrous oxide, carbon dioxide and cyclopropane, of ether and chloroform and ethyl chloride were gifts of chemistry. The synthesis of the barbiturates and of the local anesthetics, cocaine, procaine and others, also are contributions of chemistry, and it is to be hoped that further contributions will be made in the near future. The rapid development of the intravenous method of anesthesia parallels the rapid development of these barbiturates so that, between 1924 and 1934, we learned of the synthesis of barbiturates that would produce long-lasting anesthesia, then of other substances of the series that would bestow anesthesia for a somewhat shorter period and, finally, of still other barbiturates that would cause anesthesia of sufficiently brief duration so that the method is now firmly established in clinical practice and is becoming widely used throughout the world. The investigations of biochemists in the developing of new quantitative methods of analysis for the identification of drugs has made it possible to investigate many problems in anesthesia. As examples, I might cite the work of Dunlop,[7] in Osterberg's laboratory, where a method of identifying procaine in great dilution was employed. This permitted Dunlop to investigate the fate of procaine in the dog and he was able definitely to establish the role of the liver in the destruction of this drug (1935). Delmonico,[8] also working in Osterberg's laboratory, carried out a method of quantitatively estimating samples of barbiturates. This method permitted Delmonico to investigate the fate of certain barbiturates in the body. These are two of innumerable instances wherein methods developed through chemistry have permitted investigation of anesthetic agents used clinically and experimentally. Without the aid of chemists the work could not have been begun.

Physics has taught us to understand some of the actions of gases and liquids and also has contributed methods of measurement that have broad application in the field of anesthesiology. At present, a means of analyzing mixtures of gases by passing them through a fixed, small aperture under constant pressure, and timing the flow, is giving good results in the

[3] T. H. Seldon, unpublished data.

[4] E. C. Rosenow and R. M. Tovell, *Am. Jour. Surg.*, 34: 474–485, 1936.

[5] Crocker and Knight, quoted by A. B. Luckhardt and J. B. Carter.

[6] A. B. Luckhardt and J. B. Carter, *Jour. Am. Med. Asn.*, 80: 765–770, 1923.

[7] J. G. Dunlop, *Jour. Pharmacol. and Exper. Therapy*, 55: 464–481, 1935.

[8] E. J. Delmonico, *Proc. Staff Meet., Mayo Clin.*, 14: 109–112, 1939.

hands of H. O. Brown[9] working in Boothby's laboratory. The physical principles concerned in the use of a light gas, such as helium, in the treatment of asthma is an illustration of the practical clinical application of physical principles. The clinical problem is that the patient is unable adequately to ventilate himself with air because air can not be easily drawn through the air passages, the caliber of which has been diminished by the disease, without extreme physical effort. However, by using a mixture of oxygen and helium rather than the mixture of nitrogen and oxygen that exists in air, the patient is able to breathe with not more than the physical effort exerted by a well person. Another application of physical principles has caused a therapeutic procedure to be developed, the use of which is becoming well recognized and will be widely applied. It concerns the difficulty of a patient after operation to ventilate himself with air or oxygen when there is present in his air passages any solid or fluid material which tends to obstruct his respirations. It has been found that by inserting a lighted, tubular instrument into the air passages, the obstructing material can be aspirated. This permits the patient to breathe in more normal fashion and often to avoid the development of pneumonia which carries with it a considerable mortality or subsequent morbidity.

In the field of electrical physics many contributions have been, and will be, made. An example is the use of the photo-electric cell in determining the coagulation time of blood. The use of the electrocardiograph has permitted study of the effect of various anesthetic substances on the heart. Betlach[10] used the string galvanometric electrocardiograph. Others have used more modern apparatus and the problem remains one of those which will be of interest in the future. I am greatly interested to see whether or not devices may be made that will permit us to follow functions of the cardiovascular system in many operating rooms and bedrooms throughout several hospitals and correlate information for the benefit of patients who are unable to help themselves. Both anesthetist and physicist are greatly interested in air conditioning of operating rooms and hospital rooms; the physicist must provide means of testing the air and the physician must observe any untoward effects on the patient. The loss of body heat by the patient also concerns both physicist and physician, and this problem must yet be investigated. Control of static electricity has become of great importance to the anesthetist recently because he employs various inflammable and explosive mixtures in connection with inhalation anesthesia. Here again the anesthetist must turn to the physicist for information. An excellent example of cooperation in this problem has been the combined efforts of Tovell and Woodbridge, respectively of Connecticut and Massachusetts, together with Horton of the Massachusetts Institute of Technology. From their study has come the intercoupler, a device which connects the anesthetist, the gas machine, the patient and any fourth object or person that must be brought in contact with them. The principle is that the static electricity must pass through a given amount of resistance so that it can not suddenly reach its objective and cause a spark that is hot enough to ignite the vapor or gases. So far as I know there have been no explosions where this intercoupler has been used.

In resuscitation, a type of work which naturally falls to the anesthetist, the physicist has a real interest. Mechanical means of producing artificial respiration have been investigated and some of them have proved effective, although much remains to be done in this field. The so-called iron lung has proved of value, and in surgical cases mechanical devices for pulmonary ventilation have been useful. However, because of the expense of the equipment and the consequent small demand for it, the field has not been thoroughly investigated. In the administration of anesthetic agents by inhalation it has been necessary for so-called gas machines to be devised. Again, physical principles govern the construction of these devices but the construction is not always carried on under the direction of a physicist; this no doubt has retarded the development of an entirely satisfactory machine. For example, when it was decided that ether should be administered with gases an attachment for administration of ether was added to the gas machine. The flow of the gases through the ether bottle resulted in an undetermined concentration of ether in the breathing bag. As yet, no one has devised a means of indicating when concentration of this ether vapor is too strong and consequently the use of the gas machine is often unsatisfactory.

The preservation of blood by chilling has been a great boon to the physician, who frequently finds use for the transfusion of blood. It is to be hoped that some physical means other than centrifuging may be developed for the purpose of separating the cellular elements of the blood from the fluid portion. There are many uses for blood and many uses for each of the elements of blood. The existence of war increases the urgency for solution of this problem.

When venipuncture is difficult because of smallness of veins, it has been shown that by application of heat to an extremity, small veins may be better filled and venipuncture made easy.

The fields of pharmacology and physiology are of

[9] H. O. Brown, unpublished data.

[10] C. J. Betlach, *Jour. Pharmacol. and Exper. Therapy*, 61: 329–337, 1937.

such direct application to the work of the anesthetist that the point need not be especially illustrated. It may be said, however, that many agents and methods contributed by chemists and physicists are first applied by the physiologist and pharmacologist to determine the use to which the new agents or methods can be put before they are applied clinically. While the first agents to be introduced may have come into use without such preliminary investigation, those that are introduced to-day are subjected to thorough tests. The interest of the physician anesthetist in the effects produced by anesthetic substances and other drugs which he uses is evident in the work of Searles,[11] who studied the effect of ether and sodium amytal anesthesia on the blood. Such investigation emphasizes the importance of collaboration of clinician and scientist for, if possible, the separate effect of the anesthetic and of any other drug that may be used must always be determined. It is in this field that the study of psychology becomes important, for it must never be forgotten that the psychologic processes of the animal differ from those of the human being. Therefore, it is not always possible to apply the information obtained from animal experimentation to clinical application of the agent.

The study of languages requires the attention of the anesthetist. Obviously, in scientific writing, many of the same words are adopted by users of different languages, but it is of great importance to the reader of scientific articles that the author should have had at his command a sufficient choice of words that his meaning may be exactly expressed and that, if his article is translated into another tongue, it will not suffer thereby.

By mathematicians many fundamental contributions had been made, usually through physics; however, the mathematician is indispensable in the correlation of data that are gathered not only in the course of experimentation but also in clinical application of anesthetic preparations. It is not easy for those of us who are not mathematicians to assemble statistics derived from our work and properly to interpret their value.

I hope that these illustrations of the indispensable value of the fundamental sciences in the establishment of anesthesiology, a new specialty in medicine, will interest you sufficiently so that your continued assistance may be anticipated. Unfortunately, those of us who are interested in the development of this new specialty and those who will follow us in the field of endeavor are not sufficiently well equipped from your point of view. In the absence of an individual genius, then, development of the new medical specialty will, in all probability, take place in institutions where scientists and clinicians can work together and where facilities exist whereby investigation can be carried on, new facts established and new agents and methods developed; these factors, together, will permit further reduction of pain among human beings. In the future, I hope that animal experimentation, made painless by anesthesia, will be accepted by those who have condemned it in the past when their attention is called to the fact that needless pain caused by disease will be spared both animals and man.

OBITUARY

PHOEBUS AARON THEODOR LEVENE
1869–1940

PHOEBUS AARON THEODOR LEVENE, member emeritus of the Rockefeller Institute for Medical Research, died at his home in New York City on September 6, 1940. He had returned from a vacation in Montana but a short time before, and was about to resume his insistent quest for the knowledge of life processes.

Dr. Levene was born in Sagor, Russia, on February 25, 1869. When he was about two years old, the family moved to St. Petersburg.

The young Levene entered the Classical Gymnasium, and from this school he enrolled in the Imperial Military Medical Academy in St. Petersburg. He was one of the five Jewish students allowed to enter his class. At that time Borodin was the professor of chemistry. It was Borodin's son-in-law, Professor Dianin, who allowed Levene to carry on work at will in the chemical laboratory.

[11] P. W. Searles, *Am. Jour. Surg.*, 41: 399–404, 1938.

During the year 1891, because of the growing anti-Semitism in Russia, and the resulting need for education of the younger members of the family, the Levenes migrated to the United States, arriving July 4, 1891. After a few months, Levene returned to St. Petersburg to finish his examinations for his medical degree. He was graduated in the autumn of 1891. He returned to New York in March, 1892, and soon took his examinations for the practice of medicine and practiced on the lower East Side until 1896.

Because of his conviction of the importance of chemistry to the advancement of medical science, he enrolled at Columbia as a special student in the Department of Chemistry in the School of Mines. At the same time Professor J. J. Curtis kindly gave him a place to work in his laboratory at the College of Physicians and Surgeons. In later years he supplemented this training by periods spent in Berne under Professor Drechsel, in Marburg under Professor Kos-

sel, in Berlin under Professor Emil Fischer and in Munich in the Technische Hochschule.

Levene's strong bent toward research on the chemical nature of biological materials was but partly satisfied in the limited time permitted by his medical practice. To the good fortune of biochemistry, the way was opened for him to devote all his efforts to these studies by his appointment in 1896 as associate in chemistry at the State Pathological Institute of New York.

In November of the year 1896 he developed tuberculosis and went to Saranac Lake as a patient of Dr. Baldwin. He then went to Davos for a year. All this time Professor von Giesen held the post in the State Pathological Institute open for him. When he returned from Switzerland, though far from well, he at once went to work. During the years 1900–1902 he worked at the Saranac Laboratory for the Study of Tuberculosis because the State Pathological Institute was undergoing reorganization. In 1902 he returned to work there under Dr. Adolf Meyer.

In January, 1905, came his great opportunity when at the invitation of Dr. Simon Flexner he joined the small group who formed the laboratory staff of The Rockefeller Institute for Medical Research, where in July, 1907, he was advanced to the rank of member.

The Rockefeller Institute provided the ideal environment for the flowering of his genius. The stimulus of an inspiring atmosphere, the unexcelled laboratory facilities and the opportunity for choice of problems without regard to their difficulty and length afforded a widened horizon of scientific endeavor to which he devoted his abilities for thirty-five years. Under his sympathetic guidance several distinguished biochemists laid the foundations of their important careers. In July, 1939, he retired and became a member emeritus of the institute but still continued his researches with unabated energy.

Dr. Levene's eminence in his chosen field was recognized by the award to him of the Willard Gibbs Medal of the Chicago Section of the American Chemical Society in 1931, and of the William H. Nichols Medal of the New York Section in 1938. He was a member of the National Academy of Sciences, American Philosophical Society, Bayerische Akademie der Wissenschaften, Royal Society of Science (Upsala, Sweden), Halle Akademie der Naturforscher, Société Royale des Sciences Medicales et Naturelles de Bruxelles and many professional societies.

Dr. Levene married Anna M. Erickson, of Lewistown, Montana, in 1920. Through their congenial tastes there grew a home of spiritual and artistic harmony, the center for a wide circle of devoted friends from many fields.

In such fortunate circumstances Dr. Levene displayed an extraordinary capacity for hard work. He read voraciously in several languages on many subjects. In addition to directing the researches of a number of coworkers, he carried on with his own hands a large volume of experimental work of great delicacy. In the laboratory and in his private library at home, chemistry and its medical significance were a supreme passion; in the midst of his friends, he gave full play to his varied interests in classical and modern art.

To discuss the wide scope of Levene's scientific activities in the space of a few paragraphs is not easy. Fortunately for the reviewer, however, although these researches relate to almost all fields of biochemistry, they present a logical and coordinated pattern. He wrote a number of comprehensive summaries and two monographs, in the preparation of one of which it was the privilege of the writer to collaborate.

Dr. Levene began his career of independent research with an investigation of the transformation of proteins into carbohydrates by the animal organism. This undertaking was an intuitive expression of his lifelong interest in these two important types of biological materials. Two of his early studies were of outstanding significance to protein chemistry: improved analytical methods, developed in collaboration with Dr. D. D. Van Slyke, and the isolation of one of the first crystalline intermediate products of protein hydrolysis, in cooperation with Dr. George B. Wallace.

Of all tissue components, the proteins have offered the supreme challenge to the skill and ingenuity of the chemist. At the beginning of this century the work of Emil Fischer had resulted in his enunciation of the polypeptide theory of structure, based on the isolation of various amino acids from the hydrolytic products of these complex molecules. During the nineteen-twenties this theory was challenged, particularly by a hypothesis in which the molecule was regarded as being made up of diketopiperazine rings—condensed amino acid cycles—joined by auxiliary valence forces. Levene had previously noted the great ease with which a substance of this latter type, isolated by him in 1906, lost its optical activity. A systematic study, extending over several years, of the racemization of a series of synthetic diketopiperazines and peptides revealed the difference in behavior of the two groups of compounds. When this technic was applied to the proteins themselves, they were found to resemble more closely the chain structures than the cyclic compounds, thus supporting Fischer's theory.

The major emphasis in Levene's protein studies, however, was on his brilliant investigations of the characteristic non-protein constituents of the nucleoproteins and of the glycoproteins, namely, the nucleic acids and the nitrogenous sugars, of which brief mention will be made later. It should be noted that both

these types of substances are substituted sugars, thus forming a logical connecting link between his broad interests in proteins and the carbohydrates.

As in the case of proteins, two conflicting theories have been advanced for the structure of the polysaccharides, one claiming a union of the individual components in chain form by chemical valency, the other assuming cohesion of ring forms through subsidiary valency. Levene's approach to this problem was through the study of the natural tendency toward condensation of the simple sugars under mild conditions. In practically every case the product was found to be a chain structure. The results have therefore supported the chemical valence theory of union between parts of the polysaccharide molecule, a view now generally accepted.

Two other important aspects of sugar structure received illumination through Levene's researches—the evolution of a method to determine the point of linkage in substituted carbohydrates and the elucidation of ring structures of sugars and their derivatives. Both technics were essential in unraveling the complicated formulas of the nucleic acids.

At the beginning of this century, knowledge of the structure of the nucleic acids, which are essential constituents of the chromosomes, was in a rudimentary state. It had been shown only that they were composed of phosphoric acid combined with nitrogenous and non-nitrogenous substances. There was no information regarding the nature of the non-nitrogenous compounds, the quantitative relationships between the different components or their mode of union.

Throughout four decades these substances were under persistent investigation by Levene, with the result that their structures are now known in detail. The identification of the sugar in the so-called animal nucleic acid, which had baffled all investigators, was finally achieved in 1929 through his genius. He showed that the nucleic acids are tetranucleotides, each of the latter being composed of phosphoric acid, sugar and a nitrogenous compound. The sequence of the union of the constituents and the positions of the substituents on the sugars were then established. The sugars—ribose in plant nucleic acid and desoxyribose in animal nucleic acid—had not previously been known to occur in nature. As a result of Levene's work we have an exact concept of the structures of these huge molecules, probably the most complex biological materials whose architectural picture has been reconstructed.

At an early stage in his work Levene became interested in the unique group of substances known as glycoproteins, which contain high percentages of carbohydrate. These complex compounds were revealed by him to be derivatives of nitrogenous sugars.

The nitrogen-containing sugars in themselves constituted an extremely difficult problem. Whereas in simple sugars the position in space of every substituent had been determined, that of the nitrogen atom could not be assigned by the methods of classical organic chemistry. New, indirect procedures had to be discovered. For this purpose Levene undertook an exhaustive synthetic study of the nitrogenous and the corresponding non-nitrogenous hexoses and their derivatives. From the data the allocation of the nitrogen was deduced. This investigation marked the beginning of his fundamental studies on the correlation of chemical structure with optical activity.

Another group of compounds of complicated formulas, the lipoids, was brought into orderly classification through Levene's researches. The literature was in a sadly confused state, with as many substances described and separately christened as there were authors. By evolving methods for the preparation of these materials in pure state, however, he was able to create scientific order out of chaos in this domain. He showed that three main groups of substances exist among lipoids, two phosphorus-containing and the third phosphorus-free. Closer study demonstrated the fact that two contained a sugar in their molecules, thus cementing their relationship to his studies on other types of carbohydrates.

Through Levene's investigations on optically active materials, particularly among the sugars and proteins, he came to realize the basic significance of optical rotation both as a tool for the elucidation of structures of naturally occurring substances and as a subject of great theoretical import. The problem of configurational relationships—in preparation for which he had, at the height of his career, to renew and broaden his knowledge of advanced mathematics and physics—was to him in later years the most enthralling subject among his varied researches. In these studies, and in fact throughout all his work, he was outstandingly successful in applying the methods and theories of physical chemistry in the province of biology.

As an example of the broad perspective of his scientific philosophy, his analysis of the biological significance of the chemical individuality of tissue elements may be cited. In the first classification he placed those compounds—such as nucleic acids, lipoids and conjugated sulfuric acids—which, though indispensable to life, exhibit no individuality, no specificity; they are found in all tissues, in all organs of all species, are invariable in their structures and occur wherever life is present. Typical of the second classification—the members of which may be present or absent in one or more organs, in one or another species, but preserve their chemical individuality in various species—are the hormones and enzymes. Finally, in the proteins we encounter a group of substances whose complex rela-

tions are still further complicated by the fact that they appear to show differences in chemical structure with variation of species.

To future generations of inquirers into the complexities of living matter, Dr. Levene extended this message of hope and confidence, which is quoted from the concluding lines of his acceptance address at the Willard Gibbs Medal presentation in 1931: "Step by step, one mystery of life after another is being revealed. Whether the human mind will ever attain complete and absolute knowledge of and complete mastery of life is not essential. It is certain, however, that the revolt of the biochemist against the idea of a restriction to human curiosity will continue. New discoveries in physics, in mathematics, in theoretical chemistry furnish new tools to biochemistry, new tools for the solution of old problems and for the creation of new ones. So long as life continues, the human mind will create mysteries and biochemistry will play a part in their solution."

LAWRENCE W. BASS

MELLON INSTITUTE

SCIENTIFIC EVENTS

ENGINEERING EDUCATION AT THE RENSSELAER POLYTECHNIC INSTITUTE

A NEW plan in engineering education will be put into practice at Rensselaer Polytechnic Institute this year. Through the cooperation of the General Electric Company, a large group of carefully selected students will attend for three consecutive months on the plants of the company.

This plan differs from other cooperative arrangements with industries for the education and employment training of engineering students in the fact that it permits graduation of the students within the regular four-year period, instead of making necessary an extra year in college.

The chief objection of the general cooperative plan —the extra year with its cost to the student in time and money—has been finally overcome. This will be accomplished mainly by including a classroom program to run currently in the plants with the practical experience program, and by arranging summer courses at the institute during which the students will make up what they missed in their absence. Another important feature contributing to the feasibility of this four-year plan is the fact that the outside courses will be concentrated in three consecutive months in the junior year alone rather than being split into alternating periods of several weeks each over several years.

The students selected will be juniors in the departments of mechanical engineering and electrical engineering. The courses will begin on April 1 and continue to July 1, when the students will return to the institute for the summer courses specially designed for them. Thus they will begin their senior year with three months of practical training behind them and at a time when they will be beginning to think most seriously of obtaining jobs after graduation. Much of the work of their last year can thus be interpreted in terms of what they observed in practical experience. Also they will have had three months to demonstrate and measure their abilities under the observation and counsel of prospective employers; the work of their senior year also can be interpreted and developed in terms of their discoveries in these respects. Naturally, the General Electric Company entered the plan with the hope that it would help make available men for permanent employment, but there is no employment obligation on the part of either the company or of the students. However, it is pointed out that the experience obviously would be valued by any employer.

In common with other cooperative "earn as you learn" plans, the student will receive wages while in training, thus enabling him to help pay his way through his last year. It is estimated he should save from $75 to $125 over living expenses.

EXTENSION COURSES IN AERONAUTICAL ENGINEERING OF CORNELL UNIVERSITY

IN cooperation with the Federal Government's program for national defense, Cornell University opened in Buffalo on October 7 an extension center giving advanced training in aeronautical engineering to employees of the aircraft industry. Unlike some programs set up by other institutions, under which employees must leave their jobs for a time to attend school, the Cornell plan will bring the faculty to the industries and give courses after working hours, so that production will not be curtailed at this critical time. These courses are the first ever given away from the university by the College of Engineering.

A staff from the college, under the direct supervision of Dean S. C. Hollister, will hold classes in Burgard Vocational High School, where facilities have been made available by the Buffalo Board of Education. The entire program will be financed without Federal or state funds.

Instruction will be offered especially for qualified employees of the Curtiss-Wright Corporation and the Bell Aircraft Corporation, where there has been for some time an acute shortage of aeronautical engineers. The immediate plan is to convert mechan-

ical, electrical, civil and chemical engineers into specialists in aircraft design. Initial enrolment will be approximately 160 students, with the prospect of increases in the future as the companies expand their organizations to handle defense orders from the government. An additional order for Curtiss-Wright planes to be built in Buffalo and St. Louis plants at the cost of $94,000,000 was announced recently while Dean Hollister was in Buffalo making final arrangements to start the training course.

Facing the prospect of a considerable expansion in their organizations, officials of the aircraft companies decided several months ago that it would be desirable to promote members of the present staffs if a way could be found to qualify them for more responsible positions. Most of the expansion in personnel could then take place in the lower grades. "A spontaneous solution to the problem appeared," according to the personnel director of one of the companies, "when Dean Hollister came to Buffalo to learn what Cornell University could do to help the aviation industry in national defense." The companies are supporting the program by offering inducements to qualified employees to take the work and by cooperating with the Cornell faculty in preparing courses of maximum practical benefit to those enrolled.

Among the first contingent of professors to leave Ithaca for Buffalo are Dr. Millard V. Barton, of the Sibley School of Mechanical Engineering, and Dr. Harold V. Hawkins, of the School of Civil Engineering. Their courses will cover the action of external forces on an airplane in flight, stresses in monocoque structures, properties of airplane materials and related technical subjects. Classes will run throughout the year, meeting four nights a week.

The Cornell plan, designed to fill a specific need in the nation's educational program as related to defense, was prepared in cooperation with Dr. Studebaker, U. S. Commissioner of Education, and Dr. Lewis Wilson, of the Office of Education in Albany, both of whom have given it their enthusiastic support.

FELLOWSHIPS IN THE MEDICAL SCIENCES OF THE NATIONAL RESEARCH COUNCIL

FELLOWSHIPS in the medical sciences, similar to those which have been administered by the Medical Fellowship Board of the National Research Council since 1922, will again be available for the year beginning on July 1. These fellowships, supported by grants from the Rockefeller Foundation to the National Research Council, are designed to provide opportunities for training and experience in research in all branches of medical science. They are open to citizens of the United States or Canada who possess an M.D. or a Ph.D. degree, and are intended for recent graduates who are not yet professionally established.

In addition to these fellowships the Medical Fellowship Board announces two new groups of research fellowships, made available through a grant from the National Foundation for Infantile Paralysis, Inc. The first group, open to applicants who hold either the Ph.D. or M.D. degree, is for the purpose of providing opportunities for special training and experience in the study of filtrable viruses. The second group, open only to graduates in medicine who have completed one or more years of hospital experience in clinical surgery and are planning a career in orthopedic surgery, is designed to provide opportunities for training and research in those basic medical sciences which will be of particular value in furthering progress in the field of orthopedic surgery.

Fellows will be appointed at a meeting of the Medical Fellowship Board about March 1. Applications to receive consideration at this meeting must be filed on or before January 1. Appointments may begin on any date determined by the board.

For further particulars, address the Secretary of the Medical Fellowship Board, National Research Council, 2101 Constitution Avenue, Washington, D. C.

THE MIDWEST WILDLIFE CONFERENCE

THE sixth annual Midwest Wildlife Conference will be held at Urbana on November 14, 15 and 16. Under the direction of T. H. Frison, chief of the Illinois Natural History Survey, which this year sponsors the conference, a program is being formulated that includes as speakers well-known wildlife technicians and zoologists from the East as well as from the Midwest.

The meeting will open with a general session in which Rudolf Bennitt, of the University of Missouri, will lead a panel discussion on the unification of conservation practices. Participating in the panel will be Aldo Leopold, of the University of Wisconsin; Charles G. Sauers, of the Forest Preserve District of Cook County, and other conservationists. The panel will be followed by two sessions running concurrently, one on fish and the other on waterfowl, upland game and furbearers. Special clinics on deer and prairie chicken are planned.

On the program for the second day are three concurrent sessions, one on fish, one on waterfowl and a third on upland game and furbearers. New features of the conference are two sessions of a non-technical nature, one for waterfowl hunters and the other for fishermen and upland game hunters, at which wildlife technicians will speak informally and answer questions put to them by the attending sportsmen.

Chairmen of the sessions include Ira N. Gabrielson, director, U. S. Fish and Wildlife Service; Walter H. Chute, director, John G. Shedd Aquarium, Chicago; Warren W. Chase, regional director, U. S. Soil Conservation Service; Arthur D. Hasler, department of zoology, University of Wisconsin, and Miles D. Pirnie, director, Kellogg Bird Sanctuary, Battle Creek, Michigan. H. H. Bennett, director of the U. S. Soil Conservation Service, will address the conference at the annual banquet on November 14.

As already reported in SCIENCE the Natural Resources Building, the new home of the Illinois Natural History Survey and the Geological Survey, on the south campus of the university, will be dedicated on November 15. The Geological Survey is sponsoring a conference on coal, oil, gas and industrial minerals, and will join the Natural History Survey in the dedication ceremonies. Participating will be representatives of the Federal and State Governments, through which construction funds were provided, and of cooperating universities, research institutions and industrial organizations. The dedication address of Dr. Isaiah Bowman, president of the Johns Hopkins University, will be followed by a reception in the new building and by a banquet in the evening.

Originating at Urbana in 1935, the Midwest Wildlife Conference has annually since that time assumed increased importance among wildlife technicians of the central part of the country. States usually represented, in addition to Illinois, are Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin. This year, Kansas and Oklahoma will send wildlife technicians to take part in the special clinic on prairie chickens planned for November 14.

AWARD OF THE WILLIAM H. NICHOLS MEDAL OF THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY

DR. LINUS PAULING, head of the division of chemistry and chemical engineering of the California Institute of Technology, has been awarded the William H. Nichols Medal for 1941 of the New York Section of the American Chemical Society, according to an announcement made by Professor Arthur W. Hixson, of Columbia University, chairman of the medal jury.

Dr. Pauling is cited "for his distinguished and pioneer work on the application of quantum mechanics to chemistry and on the size and shape of chemical molecules." The presentation will be made at a dinner of the section on March 7, at which time he will deliver the annual address of the Nichols medallist. The official statement by the jury giving the grounds for which the award was made reads:

> Dr. Pauling has profoundly influenced the whole of chemical thought. His study of "The Nature of the Chemical Bond," appearing last year, was acclaimed by critics as the most valuable work on molecular structures in relation to chemistry published for a number of years. It excited more interest and enthusiasm than any treatise on a specialized topic in chemistry since Gilbert N. Lewis and Merle Randall, of the University of California, published their "Thermodynamics" in 1923.
>
> Dr. Pauling has pioneered in applying quantum mechanics to chemistry. He has done much to explain the manner in which atoms are linked together to form molecules and why certain atoms react and combine differently under different circumstances. His contributions have been technical as well as theoretical. He has developed methods of testing conclusions drawn from theoretical study, and means of measuring the size and shape of molecules.
>
> Because of the chemical rules which have been formulated by Dr. Pauling, chemists are able to predict the reaction of certain molecules under various conditions. His work applies equally to organic, biological and inorganic chemistry. He has shed light on the shape and activity of the protein molecule. By using actual experimentation to check his theoretical explanations of the manner in which atoms in the protein molecule must combine, Dr. Pauling has eliminated a number of hypotheses concerning the shape of the molecule.
>
> It was Dr. Pauling who discovered that a radius of activity could be assigned to each atom; that is, there is a definite amount of space "filled" by each atom with its force. Adjacent carbon and oxygen atoms are therefore usually at a set, determinable distance apart. When this distance varies it is an indication of some force exerting influence. Dr. Pauling has originated methods of accounting for such forces and consequently of explaining in part some of the erratic properties of atoms.
>
> Dr. Pauling has been responsible for the application of the resonance phenomenon to chemistry. This phenomenon accounts for the attraction and repulsion that atoms have for one another, and also in part for the manner in which atoms bind together to form molecules. It aids in explaining valence bonds, the links between atoms.

SCIENTIFIC NOTES AND NEWS

DR. JAMES EWING, emeritus professor of pathology at the Cornell University Medical School and formerly director of Memorial Hospital for the treatment of cancer and allied diseases, was presented with the fourth Clement Cleveland Medal of the New York City Cancer Committee at a dinner given on October 30 in the National Arts Club. The medal was awarded for "outstanding work during the year in the campaign to control cancer."

FOR his article entitled "The Surface of the Nearest

Star," printed in the *Journal* of the Society of Motion Picture Engineers, Dr. Robert R. McMath, director of the McMath-Hulbert Observatory of the University of Michigan, was presented with the Journal Award of the society at the banquet held at the recent annual meeting at Hollywood, California.

MEDALS for distinguished service to China were presented on October 25 on behalf of the Chinese Government by Dr. F. C. Yen, formerly Chinese National Health Administrator, to eleven directors of the American Bureau for Medical Aid to China. Among those who received medals are Dr. James B. Murphy, member of the Rockefeller Institute for Medical Research in charge of cancer research; Dr. George Morris Piersol, professor of medicine in the Graduate School of Medicine of the University of Pennsylvania and medical director of the Bell Telephone Company of Pennsylvania; Dr. Homer W. Smith, professor of physiology, and Dr. George B. Wallace, professor of pharmacology, both of the New York University College of Medicine.

DR. T. HARPER GOODSPEED, director of the botanical gardens of the University of California, has been elected to honorary membership in the Santa Barbara Botanic Garden.

A MEDAL has been established by the Royal Astronomical Society of Canada to be awarded annually for work by amateur astronomers. It will be known as the Chant Medal, in honor of Dr. C. A. Chant, director emeritus of the Dunlap Observatory of the University of Toronto and a past president of the society. It is hoped to make the first award next January. The medal will be of silver and will be three inches in diameter.

Nature states that the following are serving as officers of the Society of Chemical Industry for 1940–41: *President,* Professor J. C. Philip; *Honorary Treasurer,* Dr. L. H. Lampitt; *Honorary Foreign (or Overseas) Secretary,* Dr. Wm. Cullen; *Chairman, Bureau of Chemical Abstracts,* Dr. L. H. Lampitt; *General Secretary,* H. J. Pooley, Clifton House, Euston Road, London, N.W.1.

DR. L. C. KNIGHT, professor of mathematics at the College of Wooster, has retired after thirty-two years of service.

DR. JOHN EVERETT GORDON, professor of preventive medicine and epidemiology at the Harvard Medical School and director of the new Harvard public health unit and the Harvard-Red Cross Hospital in England, has been appointed to succeed the late Dr. Hans Zinsser as Charles Wilder professor of medicine and epidemiology.

DR. HERBERT A. YOUNG, assistant professor of chemistry at the College of Agriculture at Davis of the University of California, has been appointed acting chairman of the department of chemistry to fill the vacancy left by the death of Professor C. S. Bisson.

LEONARD W. MAYO, chairman of the Westchester, N. Y., County Council of Social Agencies and president of the Child Welfare League of America, has been appointed dean of the School of Applied Social Sciences of Western Reserve University. Mr. Mayo will take up the work of associate dean and professor of social administration in January and will succeed Dr. J. Elbert Cutler as dean in June.

PROMOTIONS in the School of Medicine of Western Reserve University include Dr. Claude S. Beck, who has been made professor of neurosurgery, and Dr. John A. Toomey, who has been appointed professor of clinical pediatrics and contagious diseases.

DR. L. DAVID HINER, of the department of pharmacy of the South Dakota State College, has been appointed professor of pharmacy at the Ohio State University.

DR. LAURENCE H. SNYDER, of the Ohio State University, will be visiting professor of medical genetics at the Medical School of Duke University during the winter quarter of 1941. While there he will also lecture on medical genetics at the University of North Carolina and at Wake Forest College.

PROFESSOR GEORGE POLYA, who has been at the Technische Hochschule in Zurich for two years, has joined the staff of the department of mathematics at Brown University.

DR. JAMES R. SCOTT, professor of health education at the University of New Mexico, has been appointed state director of public health of New Mexico. He succeeds Dr. Edwin B. Godfrey, of Santa Fe, who resigned several months ago.

ACCORDING to the *Journal* of the American Medical Association, Dr. James F. Worley, senior surgeon, U. S. Public Health Service, medical director of the Alaska division of the Indian Medical Service, Juneau, has been transferred to Minneapolis as medical director of district Number 1, comprising the states of Michigan, Wisconsin, Minnesota, Iowa, Nebraska and North and South Dakota.

DR. WILLIAM C. MEYER, professor of astronomy at the University of California at Berkeley, has been appointed associate director of relations with schools for the university. Dr. Hiram W. Edwards, who is director, will continue to work at Los Angeles, and Dr. Meyer will supervise activities in the northern part of the state.

DR. C. I. BLISS, of Sandusky, Ohio, has been ap-

pointed biometrician in the Agricultural Experiment Stations at New Haven and at Storrs, Conn. For the present he will work on a half-time basis. During the remainder of the year he plans to continue his work as consulting biometrician at various institutions.

SINCE July 1, 1939, the Rockefeller Foundation has supported a research program on molecular spectra at the University of Chicago under the direction of Professor Robert S. Mulliken, with the cooperation of Dr. Hans G. Beutler. Dr. Lyle W. Phillips, research assistant the first year, has accepted a position as instructor in physics at the University of Illinois. Dr. Anthony Turkevich is now research assistant. Dr. Carol A. Rieke has continued as research assistant in charge of computation. Dr. Stanilaus Mrozowski, formerly docent in physics at the University of Warsaw, has recently become a research fellow.

PROFESSOR FRANK H. SMITH, of the department of engineering of the University of Michigan, has leave of absence for a year to serve with the ordnance department of the U. S. Army.

IT is stated in the *Journal* of the American Medical Association that a medical subcommittee of the Committee to Defend America by Aiding the Allies, of which William Allen White, editor of the Emporia, Kansas, *Gazette,* is chairman, has been formed. The subcommittee urges physicians to enroll in local branches of the main committee, to send letters and telegrams to congressmen and presidential candidates stressing the need for all possible aid to Britain and to send contributions to the national committee. Members of the subcommittee are Drs. Emile Holman, Eugene S. Kilgore and Ray Lyman Wilbur, San Francisco; Roger I. Lee, Boston; Warfield T. Longcope, Baltimore; John H. Musser, New Orleans, and Dallas B. Phemister, Chicago.

DR. CARL D. LARUE, of the department of botany, has leave of absence for the first semester from the University of Michigan to study rubber cultivation in Bolivia.

DR. HERMANN J. MULLER has accepted the invitation of Amherst College to work in the department of biology as guest investigator during the academic year 1940–41. Dr. Muller has been a member of the staff at the Institute of Animal Genetics at Edinburgh for the past two years. He recently returned to the United States, as work in genetics has been discontinued in Scotland because of the war. Dr. Muller will continue his work on gene mutation and chromosome breakage in Drosophila at Amherst.

DR. B. GOTTLIEB, formerly director of the histologic laboratory of the Dental School of the University of Vienna, is now on his way to the United States. He will be associated with the Dental School of the University of Michigan.

The New York Herald Tribune's tenth annual Forum on Current Problems, organized under the general subject, "America's Second Fight for Freedom, 1776–1940," was held on October 22 at the Waldorf-Astoria Hotel. Among the speakers in the second session, entitled "Science and Industry Mobilize," were Professor Harlow Shapley, director of the Harvard Observatory; Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, and Dr. Harold C. Urey, of Columbia University.

DR. CHARLES ARMSTRONG, senior surgeon of the U. S. Public Health Service, National Institute of Health, Washington, D. C., delivered the first Harvey Society Lecture of the current series at the New York Academy of Medicine on October 31. He spoke on "Studies on Lymphocytic Choriomeningitis and Poliomyelitis."

THE Western Society of Naturalists will meet at the University of California at Los Angeles on December 18, 19 and 20. Two symposia have been arranged; one on "Training for Research and Instruction in the Biological Sciences," and the other on "Perspective in Marine Biology." In addition a number of scientific papers will be presented. Professor Wesley R. Coe, of Yale University, will make an address at an evening smoker on December 18.

JAMES STOKLEY, of Science Service, gave on October 22 the first Francis Bergen Memorial Lecture of the 1940–41 season at Yale University. His subject was "Astronomical Adventures."

DR. ARNOLD L. GESELL, professor of child hygiene at Yale University, will give an address entitled "The First Five Years of Life" at the annual meeting of the Massachusetts Society for Mental Hygiene, which will be held at the Twentieth Century Club, Boston, on November 21.

THE fifty-sixth annual autumn meeting of the Indiana Academy of Science will be held from November 14 to 16 at Muncie, with the Ball State Teachers College as the host institution. Frank N. Wallace, state entomologist, will preside. An attendance of about five hundred is expected.

THE registered attendance at the sixty-ninth annual meeting of the American Public Health Association and meetings of related organizations held in Detroit during the week of October 7 was 3,187. Delegates came from every state in the Union, the District of Columbia, Alaska, Hawaii, Puerto Rico, Canada, Cuba, Mexico, Denmark, China and New Zealand. The officers elected for the year 1940–41 are as follows: *President:* W. S. Leathers, Nashville; *President-*

elect: John L. Rice, New York; *Vice-president:* Robert D. Defries, Toronto; *Vice-president:* Charles Edward Finlay, Havana; *Vice-president:* Selskar Gunn, New York; *Treasurer:* Louis I. Dublin, New York; *Chairman of the Executive Board:* Abel Wolman, Baltimore; *Executive Secretary:* Reginald M. Atwater, New York. A Committee on Public Health in the National Defense was appointed with the following personnel: W. S. Leathers, chairman, Stanley H. Osborn, Huntington Williams and Abel Wolman. Among the resolutions passed was one emphasizing the necessity for maintaining civilian health as essential to national defense and pledging the united support of members to national defense and to the maintenance of health in a free people. The seventieth annual meeting will be held in Atlantic City, N. J., in October, 1941.

THE School of Mathematics of the Institute for Advanced Study each year allocates a small number of stipends to gifted young mathematicians and mathematical physicists to enable them to study and to do research work at Princeton. Candidates must have given evidence of ability in research comparable at least with that expected for the degree of doctor of philosophy. Blanks for application may be obtained from the School of Mathematics of the Institute, Fuld Hall, Princeton, N. J., and are returnable by February 1, 1941.

ANNOUNCEMENT has been made by the Finney-Howell Research Foundation, Inc., that applications for fellowships for next year must be filed in the office of the foundation, 1211 Cathedral Street, Baltimore, Md., by January 1. This foundation was provided for in the will of the late Dr. George Walker, of Baltimore, for the support of "research work into the cause or causes and the treatment of cancer." The will directed that the surplus income from the assets of the foundation together with the principal sum should be expended within a period of ten years to support a number of fellowships in cancer research, each with an annual stipend of two thousand dollars, "in such universities, laboratories and other institutions, wherever situated, as may be approved by the board of directors." Fellowships are awarded for the period of one year, with the possibility of renewal up to three years; when deemed wise by the board of directors, special grants of limited sums may be made to support the work carried on under a fellowship.

THE new session of the faculty of medical science of King's College, London, located until lately at Glasgow, opened at the medical school of the University of Birmingham on October 9.

DISCUSSION

MULTISENSUAL MATHEMATICAL TERMS

MATHEMATICS belongs to the many smaller, but now very active, scientific laboratories of the lexicographers. In a paper by H. Poincaré (1854–1912) read at the Fourth International Congress of Mathematicians, held at Rome, Italy, in 1908, it is asserted that mathematics is the art of giving the same name to different things. Hence the use of multisensual terms in mathematics is not exceptional even if it requires that the reader select meanings when he may not be in position to decide wisely. In very early times mathematics devloped in part a special language, as may be seen in the ancient Babylonian algebraic writings which have only recently been deciphered by O. Neugebauer and others. In one of the most influential medieval mathematical books called "Summa" (1494) its author, L. Pacioli, seriously asked the question whether it is not a contradiction to say that when we multiply by a number which is less than unity the product is less than the multiplicand, since the Bible uses the term "multiply" to mean increase.

In more recent times the mathematicians have greatly extended the use of the term "multiply" by not only multiplying by negative and complex numbers but also by multiplying where no numbers at all are involved, as in the case of group operations where the term is used simply to denote the combination of elements and is sometimes used interchangeably with adding. In the ancient mathematical literature the omission of a symbod of operation between two elements commonly implied addition, but since medieval times it more commonly implies multiplication. While multiplication at first implied only a special kind of addition, *viz.*, the case when the addends are equal to each other, it has assumed during the ages meanings which have little in common with this original meaning and the lexicographers would probably find it impossible to furnish a satisfactory explanation of these elementary extensions of meanings.

Among the many instances of mathematical terms which have become multisensual much more recently than the term multiplication we may mention the term group, which is one of the many simple English words whose mathematical meaning has become difficult and is now often misunderstood even by writers on mathematical subjects. As a technical term it was introduced by a young Frenchman, E. Galois (1811–1832), who was practically unknown at the time of his early death, but whose reputation has grown since then and is now one of the greatest among the comparatively small galaxy who became known solely on

account of their mathematical ideas whose fruitfulness was developed by their successors. At first this term had a very simple meaning, representing merely a set of distinct permutations which have the property that they include the product of every two of them and the square of every one. Surely this is not a difficult concept for the human race to acquire explicitly as late as the first half of the nineteenth century.

The difficulty among mathematicians began to exhibit itself when, about fifty years after this technical term was introduced, efforts were made to define it abstractly and to base an abstract theory on it. This theory became elegant and useful, but it created a kind of strait-jacket which seemed to interfere with the freedom of action which many mathematicians enjoy, and it naturally curbed productivity even if it did not create a barrier thereto. A central idea of this abstract theory is that the associative law must be obeyed when the elements of a group are combined. In neither of two recent large general dictionaries of the English language, *viz.*, Webster's "New International Dictionary" (1938) and the "New Standard Dictionary" (1938) is the associative law made a definite part of the definition of the mathematical term group, notwithstanding the fact that one could not construct by means of the definitions which they give an extensive and useful abstract theory of groups.

In a recent book entitled "Premières leçons sur la théorie générale des groupes" (1935) G. Bouligand asserted (page 5) that with each mathematical proposition there is associated hereafter a group composed of all the modifications leading from one case of exactitude to a new case of exactitude. This is perhaps the vaguest and most objectionable definition of the term group that has ever appeared in a text-book and exhibits how far this particular mathematical term has wandered during a century from its first simple definition. With various other sciences mathematics is creating a kind of Tower of Babel with too few common terms besides the Ph.D. degree. It should be emphasized that the multisensual terms are even more confusing than the multitude of terms since the former frequently make it necessary to select from an ever growing list of concepts which may vary widely, while dictionaries are more apt to clarify the latter.

G. A. MILLER

UNIVERSITY OF ILLINOIS

HOLLY DEFOLIATION PREVENTED BY a-NAPHTHALENEACETIC ACID[1]

a-NAPHTHALENEACETIC acid has received considerable attention since Gardner, Marth and Batjer[2] reported its value in preventing fruit drop in apples. Another use for this chemical that promises to be of value to holly growers has been found at the Oregon State Experiment Station. The defoliation of holly sprays and wreaths during shipment at Christmas time often results in large losses. Spraying or dipping holly in a-naphthaleneacetic acid previous to shipment offers a method to prevent this loss.

Previous work at the Oregon Experiment Station has shown that holly is defoliated either by the presence of ethylene gas or high humidity. In the present experiments the holly was subjected to both ethylene gas and high humidity, but some of the lots were previously sprayed with solutions of a-naphthaleneacetic acid, and others were sprayed with water. Branches of holly (*Ilex aquifolium*) were sprayed and then placed in jars with apples as the source of ethylene gas. Free water was present on the sides and bottom of the jars. In 48 hours the holly sprayed with water alone was completely defoliated. The leaves began to drop from holly sprayed with .001 per cent. of a-naphthaleneacetic acid in 48 hours, but defoliation was not completed for 144 hours. The holly treated with .005 per cent. did not begin to defoliate until after eight days, and complete defoliation occurred in ten days. The leaves were firmly attached on the holly sprayed with .01 per cent. a-naphthaleneacetic acid after fourteen days. Later this lot of holly turned black and decayed without shedding its leaves. The severity of this test is evidenced by the complete defoliation of the untreated lot of holly in 48 hours. Other sprayed and unsprayed lots of holly were packed in wet paper, and these were held at 75–85 degrees for one week. Defoliation had occurred on all unsprayed lots of holly, but those sprayed with .01 per cent. a-naphthaleneacetic acid had all their leaves firmly attached at the end of the experiment.

J. A. MILBRATH
HENRY HARTMAN

OREGON STATE COLLEGE

ONCOMING REVERSAL OF THE HUMAN GROWTH TIDE

RECENT completion of a study of height, weight and menarchial records for over 65,000 freshmen, matriculating in four state universities in recent years, has shown that the reversal in the human growth tide hinted at in 1938[1] is now becoming more definite. The mean age for onset of the menses, which for many years had been coming progressively earlier with successive birth

---

[1] Published as Technical Paper No. 355 with the approval of the Director, Oregon Agricultural Experiment Station. Contribution of the Departments of Botany and Horticulture.

[2] SCIENCE, n. s., 90: 2331, 208–209, 1939.

[1] C. A. Mills and L. B. Chenoweth, *Human Biol.*, 10: 547–554, 1938.

years of freshman girls, has now reversed its trend. At the Women's College of the University of North Carolina, freshman girls born since 1918 have shown a later mean menarchial age for each successive birth year (1939–40 entering class not included). At the University of Kansas and at Cincinnati the reversal came with those born in 1920, while at the University of Wisconsin it was shown by those born in 1922 and by the whole entering class of 1939–40. While the actual changes in menarchial age are still small and not mathematically significant, the coincidental reversal in trend in all the states studied, after a number of years of steady progress toward earlier menarche, lends emphasis to the likelihood that a real biologic change is taking place.

The upward trend in student stature, so commonly remarked about and attributed to a better dietary, also shows evidence of reversal in the more southerly states. The accompanying figure indicates the height-weight

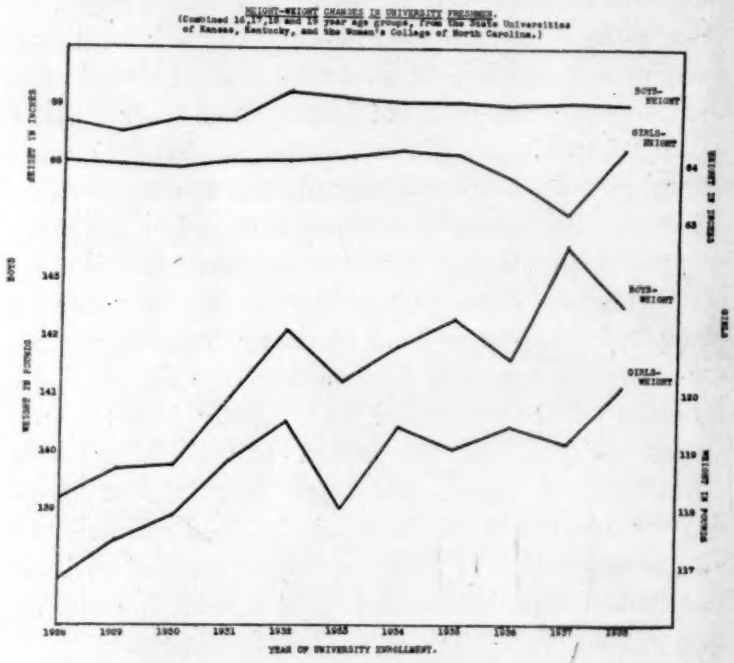

FIG. 1

changes that have taken place among freshmen entering the state universities of Kansas, Kentucky and North Carolina (Women's College only). A steadily progressive, although slight, decline in male height has occurred since the entering classes of 1932. Height of the girls showed a decline from the entering class of 1934 to that of 1937, with a sharp recovery in the 1938 entering classes. Farther north, at the University of Wisconsin, gain in freshman stature is still progressing. Wisconsin freshmen are about 4 pounds heavier and the boys 1.0 inch taller (the girls only 0.1 inch) than are freshmen in states of lower latitudes.

Improvement in both height and weight with succeeding classes has been limited largely to gains in the younger age groups of each class, with stature stabilization in the older freshmen of recent years. It appears, therefore, that adult stature may well actually be receding at lower latitudes in the United States, while more rapid growth through childhood and adolescence continues to bring young people to adult stature at ever earlier ages. Even back among students in the early years of high school, this annual stature improvement at a given age is clearly evident. Signs of stabilization have appeared here also in age groups from 13 years upward, while marked annual gains still occur in the stature of any younger age group.

Since we have already shown a clear-cut relationship between the growth and onset of sexual activity in animals and their environmental temperature level or ease of body heat loss,[2] it is suspected that cessation or reversal in the human growth tide may be due to the almost continuous unseasonable warmth that has prevailed generally over the earth since 1929, except for a few very brief periods of subnormal temperatures. Both height and weight of Cincinnati high-school students of given age groups showed distinct regression from previously prevailing levels following the very severe heat of 1934.

Certainly this cessation or reversal in the growth tide can not be related to any increasing dietary inadequacy here in America among families sending children to college. The dietary of this class of people in America has probably never been better than it is to-day, especially in the wide availability of fresh fruits and vegetables at all seasons of the year. If human development *is* affected by changes in prevailing temperature level (as that of laboratory animals has been shown to be) then we may well be deeply concerned with the prospects of long-term climatic changes. The marked physical recession of mankind during the Dark Ages occurred during centuries of world warmth, while the recent racial growth expansion has come with generally lower temperatures. Earth temperatures have been trending upward again now for over eight decades, but perhaps reaching the critical level necessary to produce growth depression only with the markedly abnormal warmth that has prevailed since 1929.

From the standpoint of general racial biology, it would seem important that astronomers and climatologists direct more systematic and intensive investigations into the causative background of world weather and longer-term changes in temperature level. Weather has ceased to be merely a subject for conversational pleasantry. It is rapidly coming to be appreciated as one of the really major forces dominating man's existence.

C. A. MILLS

UNIVERSITY OF CINCINNATI

[2] C. A. Mills, "*Medical Climatology*," Springfield: Charles C Thomas, 1939.

WIDER USE FOR ACADEMY OF SCIENCE PUBLICATIONS THROUGH IMPROVED DISTRIBUTION

IN these days of crowded scientific journals the question may well be raised whether papers published by State and local academies of science receive adequate and efficient distribution. Most of these academies are time-honored institutions born in the days when natural historians discoursed on any phase of nature that happened to come to their attention. The journals of the societies were originally of broad scope and stressed the natural science of the State or locality rather than any particular field of knowledge. Much the same tradition continues.

Conditions now are vastly different. Increase in human knowledge and improvement in transportation have shifted scientists to association more by subject than by locality. A paleontologist working in New York, for example, now finds a paleontologic discovery in Alabama more vital to him than a botanical problem in his own county. True, constant contact with developments in other sciences is needed, but broad general articles of the sort appearing in SCIENCE more nearly fill this need than do the detailed studies commonly published in academy journals or transactions.

Much of the material published by academies and circulated to members is permanently shelved or even discarded because it pertains to fields in which the recipient has no immediate interest. These same articles, however, would be valued highly by workers in other areas who subscribe only to publications of their local societies. Printing of articles as separates and requiring the subscriber to indicate the publications wanted can avoid some of the waste, but will not always provide sufficiently wide dissemination of knowledge.

Is it not time for groups of academies, particularly those affiliated with the American Association for the Advancement of Science, to develop means of exchanging publications among their various members? Botanists, in a group of four cooperating academies of similar size and neighboring locations, for example, could receive the botany papers of all four societies unless they had definitely given some other preference. Paleontologists could elect geology or zoology options or some prearranged grouping suitable to their needs. As an alternative all members could select articles totaling a predetermined maximum number of page units—highly illustrated papers perhaps being given a higher page unit rating. In this way a greater proportion of academy of science publications would reach the hands of those who would value and use them, and fewer would be lost on unused shelves or filed in the waste basket. Academy memberships would be increased because of the greater return to the members.

For library use, the complete publications of each academy of science could still be bound and shelved together.

C. F. STEWART SHARPE
SOIL CONSERVATION SERVICE,
NEW PHILADELPHIA, OHIO

SOCIETIES AND MEETINGS

THE TUCSON MEETING OF THE SOUTHWESTERN DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE twentieth annual meeting of the Southwestern Division of the American Association for the Advancement of Science and of four associated societies was held at Tucson, Arizona, during the week of April 22, 1940. The associated societies were the clearing house for Southwestern Museums, the Southwestern Section of the Mathematical Association of America, the Southwestern Section of the Society of American Foresters and the Society for American Archeology.

Considering the great distances and the small number of educational institutions in this area, with less than four hundred members of the American Association for the Advancement of Science, the registration of 176 may be regarded as very good.

Five organizations joined in sponsoring the meeting and served as hosts to the visiting members and guests. They were the University of Arizona, the Desert Sanatorium of Southern Arizona, United States Coast and Geodetic Survey Magnetic Observatory, United States Southwestern Forest and Range Experiment Station and United States Department of Agriculture Soil Conservation Service.

It was the third meeting in Tucson. Southern Arizona, rich in historic background, has much to offer in the fields of interest represented in the division. All sessions were held on the campus in the commodious buildings of the University of Arizona, making it a simple matter to go from one section to another. The very spacious cactus garden on the campus was in its glory at that season and added to the pleasure of the visit to Tucson. Those going to and from Tucson by auto were also given a rare treat while traveling through the extensive desert cactus forests, all in full bloom.

The local arrangements were in charge of a general committee, headed by Dr. E. W. Haury, department of anthropology, University of Arizona, Tucson. The committee, with the aid of various local and governmental agencies, provided visitors with a wealth of

entertainment, including an informal reception on Monday afternoon at the home of President and Mrs. Atkinson, of the university.

During the week, visits were offered the scientists and their guests to the Arizona State Museum, the Arizona Pioneers' Historical Society Museum, the Tree-Ring Laboratory, the Geology Museum, the Papago Indian Arts and Crafts Board exhibit and demonstration of basketry, pottery and leather work, and the Steward Observatory, all on the campus. The Desert Sanatorium, five miles northeast of Tucson, held open house on Tuesday, as did the United States Coast and Geodetic Survey Magnetic Observatory, seven miles east of Tucson, on Wednesday afternoon.

On Thursday, special excursions of a more extensive nature were organized for persons interested in the biological, physical and social sciences. Biologists enjoyed one or more of the following trips: U.S.D.A. Soil Conservation Service Nursery, native and introduced grasses; Sahuaro National Park, giant cactus; Tucson Mountain Park Area; Santa Rita Range Experiment Station, and University of Arizona Farm. The physical scientists chose from the following: Picacho de Calera Hills, paleontology; Tucson Mountains, overthrust fault; Catalina Mountains (Sabino Cañon), metamorphism.

The social scientists were given an opportunity to visit Ft. Lowell, San Xavier Mission, Tumacacori National Monument Mission, University Indian Ruin, Casa Grande National Monument, Snaketown, excavations of Amerind Foundation near Benson, and Amerind Foundation Museum at Dragoon.

The meeting started with a general session on Monday morning, when a welcoming address was given by President Alfred Atkinson, of the University of Arizona, to which Dr. J. R. Eyer, department of biology, New Mexico College of Agriculture and Mechanic Arts, State College, and president of the Southwestern Division of the American Association for the Advancement of Science, responded. Monday evening was devoted to the annual Sigma Xi banquet, held in the ballroom of the Pioneer Hotel, followed immediately by the Sigma Xi lecture, given by Dr. Harold S. Colton, director of the Museum of Northern Arizona, at Flagstaff. Dr. Colton's lecture, which was thrown open to the public, was profusely illustrated, and dealt with "Prehistoric Trade in Arizona."

Tuesday, in addition to the section meetings, was given over to group luncheons for the "Clearing House for Southwestern Museums" and for "Mathematicians and Friends." Professor S. B. Talmage, department of geology and mineralogy, New Mexico School of Mines, Socorro, spoke to the latter group on "Evolution, Plus and Minus." The annual banquet held in the ballroom of the Pioneer Hotel was attended by about one hundred persons. It was followed by a public address by retiring president, J. R. Eyer, New Mexico College of Agriculture and Mechanic Arts, State College, on the "Responsibility of the Scientist in a Changing World Order." Mu Alpha Nu, honorary anthropological fraternity, sponsored a luncheon for members and friends on Wednesday at noon.

The annual business session of the division was held on Wednesday afternoon, at which time Dr. C. V. Newsom, department of mathematics, University of New Mexico, Albuquerque, was elected to the presidency of the Southwestern Division, and Dr. William M. Craig, department of chemistry and chemical engineering, Texas Technological College, Lubbock, was elected vice-president, for the year 1940–41. Dr. Frank E. E. Germann, department of chemistry, University of Colorado, Boulder, was elected secretary-treasurer for an indefinite term. New members of the executive committee were Dr. J. R. Eyer, department of biology, New Mexico College of Agriculture and Mechanic Arts, State College, and Dr. H. P. Mera, Laboratory of Anthropology, Santa Fe, New Mexico, to serve until 1943, and F. H. Douglas, the Denver Art Museum, Denver, Colorado, to serve until 1941.

Officers elected by the several sections were announced as follows:

Biological Section: Chairman, Dr. Harold M. Hefley, Texas Technological College, Lubbock; *Secretary,* Alvin R. Grove, University of New Mexico, Albuquerque.

Mathematical Section: Chairman, Dr. E. J. Purcell, University of Arizona, Tucson; *Vice-chairman,* Dr. Roy MacKay, Eastern New Mexico College, Portales; *Secretary,* Dr. Harold Larsen, University of New Mexico, Albuquerque.

Physical Science Section: Chairman, Dr. F. E. Roach, University of Arizona, Tucson; *Secretary,* Dr. O. B. Muench, New Mexico Normal University, Las Vegas.

Social Science Section: Chairman, Dr. W. C. Holden, Texas Technological College, Lubbock; *Secretary,* William Pierce, Texas Technological College, Lubbock.

The 1941 meeting of the division is to be held in Lubbock, Texas; the 1942, in State College, New Mexico. It was tentatively agreed that the 1943 meeting would be held in Phoenix, Arizona.

One hundred and twenty-nine papers were presented at the section meetings. The meeting was closed, except for excursions, by the Eleventh Annual John Wesley Powell Memorial Lecture on "Activities in Plant Science," by Dr. D. T. MacDougal, of the Carnegie Institution. Although Dr. MacDougal now lives in California, he was one of the founders of the Southwestern Division, and served as president of the division in 1922. The John Wesley Powell Memorial Lectures were established in 1929, in honor of the

noted explorer of the Grand Cañon of the Colorado River. Under present arrangements a lecture is delivered at each annual meeting of the division by a distinguished investigator in some field of science upon a topic of his own selection. The roll of lecturers and the fields represented are as follows:

1929. William Morris Davis, Harvard University (Geology).
1930. Rodney H. True, University of Pennsylvania (Botany).
1932. Max Pinner, Desert Sanatorium of Southern Arizona (Medicine).
1933. Aldo Leopold, University of Wisconsin (Forestry).
1934. Otto Struve, University of Chicago (Astronomy).
1935. Edgar L. Hewett, University of New Mexico (Archeology).
1936. John C. Merriam, Carnegie Institution (Paleontology).
1937. A. E. Douglass, University of Arizona (Astronomy).
1938. E. R. Hedrick, University of California, Los Angeles (Mathematics).
1939. A. H. Compton, University of Chicago (Physics).
1940. D. T. MacDougal, Carnegie Institution (Botany).

FRANK E. E. GERMANN
UNIVERSITY OF COLORADO

SPECIAL ARTICLES

A NEW TYPE OF VIRUS FROM EPIDEMIC INFLUENZA[1]

IN February and March of 1940, an epidemic of acute respiratory disease, simulating epidemic influenza, occurred at Irvington House, a convalescent home for children with rheumatic cardiac disease, located at Irvington on Hudson. Through the courtesy of Dr. Ann G. Küttner, throat washings were received from 4 cases in the first 3 days of illness and, in addition, samples of serum were taken in the acute and convalescent stages. Neutralization tests done with these sera revealed no rise in antibody titer during convalescence against 1000 M.L.D. of the PR8 strain of the virus of epidemic influenza. Mice and ferrets were inoculated intranasally with 3 of the throat washings. Two of the ferrets failed to exhibit recognizable signs of infection and their sera, taken 8 and 51 days later, respectively, failed to neutralize the standard PR8 strain of virus. Attempts to isolate a virus directly in mice from any of the throat washings were unsuccessful through 5 serial passages at 4-day intervals or 10, 21 and 23 passages, respectively, at 7-day intervals.

The temperature of the ferret inoculated with throat washings from the third patient (Lee) fell to subnormal on the 5th and 6th days. The animal stopped eating, was abnormally quiet and had some respiratory distress. At autopsy on the 6th day the only gross finding was a mild, bluish discoloration of the left lower lobe of the lung. Passage to a normal ferret was made with a suspension of lung and turbinates and 13 serial transfers were made at 4- to 6-day intervals in this species of animal. After the 5th passage a double series was maintained. In 2 of the 20 ferrets, the highest temperature was above 105° F.; in 7, it was 104–5°; in 6, between 103.5° and 104°; in 3, no evidence of fever was obtained and in 2 the temperature was subnormal. In 13 of 18 autopsied ferrets mild pulmonary lesions, usually spotty, were noted and the majority presented abnormalities of the respiratory turbinate tissue. Serum taken from the sole convalescent ferret (B77–9th passage) on the 21st day failed to neutralize 1000 or 100 M.L.D. of the mouse passage PR8 strain of virus. Hence, by the criteria established in 1937[2] this outbreak of respiratory disease was not associated with the virus of epidemic influenza.

Groups of mice were inoculated intranasally with suspensions of lung, turbinate or both from ferrets of the 5th, 7th, 8th, 9th, 10th and 13th passages and multiple transfers were made with lung suspensions by the intranasal route at 4- to 6-day intervals. Using 40 per cent. suspensions, only small lesions were as a rule observed in mice of the first 5 passages. Thereafter, an increase in severity of the disease occurred so that by the 10th transfer infections were frequently fatal within the 5-day period. With continued passage the virulence increased so that at present virus of the two series which have been continued through 40 passages produces fatal infection within 10 days when used in a 1:1000 dilution, occasionally 1:10,000, of infected mouse lung.

Throughout its development the lesions produced by the virus in the lungs of mice have been of the uniform reddish blue type seen in infections with the virus of epidemic influenza. Nevertheless, when tested against rabbit or ferret serum prepared against numerous different strains of epidemic influenza virus, no neutralization of 200 M.L.D. or less of the Lee virus was effected. It was not neutralized by rabbit sera pre-

[1] This study was assisted by grants from the International Health Division of the Rockefeller Foundation and from the Lederle Laboratories.

[2] T. Francis, Jr., T. P. Magill, E. R. Rickard and M. D. Beck, *Am. Jour. Pub. Health*, 27: 1141, 1937.

pared against several strains of poorly defined agents, probably of mouse origin, or by serum against normal mouse virus obtained from Dr. F. L. Horsfall, Jr. (Table I). On the other hand, rabbit serum prepared against one passage strain of the Lee virus completely neutralized 3 substrains established in mice with material from 3 different ferret passages (8, 8A, 13A). It was then found that the convalescent serum of ferret B77, which had failed to neutralize the PR8 strain, completely neutralized the Lee strain. The virus transferred in mice and ferrets appeared therefore to be identical.

TABLE I

COMPARATIVE SEROLOGICAL TESTS WITH EPIDEMIC INFLUENZA VIRUS (PR8) AND NEW VIRUS (LEE)

Animal	No.	Immunized with virus strain	Neutralization of 100 M.L.D.	
			Influenza virus (PR8)	Lee virus
Ferret	A7	PR8	+	0
"	1199	PR8 (hyperimmune)	+	0
"	1301	Swine	0	0
"	B66	Normal	0	0
Rabbit	N3	PR8 (hyperimmune)	+	0
"	N41	PR8	+	0
"	N47	WS	±	0
"	317	WS	0	0
"	204	Mel	+	0
"	299	BH2	+	0
"	302	Tal	+	0
"	330	Bl5	+	0
"	240	Mo5	+	0
"	241	NY2	0	0
"	226	Phila	+	0
"	214	Smithb	+	0
"	259	TF	+	0
"	327	Henry	+	0
"	N54	Lee	0	+
FOLLOWING RECEIVED THROAT WASHINGS OF PATIENTS OR PASSAGES THEREFROM				
Ferret	B32	Duke no. 7	0	+
"	B45	Duke no. 2	0	+
"	B46	Duke no. 5	0	+
"	B52	Irv. no. 1	0	0
"	B53	Irv. no. 2	0	0
"	B77	Irv. no. 3 (Lee)	0	+

The sera of the Irvington House patients which had exhibited no rise in convalescent titer against the standard PR8 strain were tested against a 10 per cent. mouse lung suspension (100 M.L.D.) of the Lee virus. The titers of both acute and convalescent sera of patient, Lee, were approximately the same when measured against PR8. Against the Lee strain the acute titer was 0; the convalescent titer, 120. A similar result was obtained with sera of 2 others, while in one instance no difference was detected. Sera from 4 other patients who had been sick during the epidemic were fortunately available. All these also showed in convalescence a pronounced rise in antibodies to the Lee virus but not to PR8 (Table II). These results seem clearly to establish the causal association of Lee virus with the Irvington House epidemic and to demonstrate the lack of serological relationship of that virus to strains of virus isolated from other epidemics of influenza.

TABLE II

COMPARISON OF NEUTRALIZING ANTIBODIES AGAINST LEE VIRUS AND THE PR8 STRAIN OF EPIDEMIC INFLUENZA VIRUS IN SERUM FROM PATIENTS IN DIFFERENT EPIDEMICS

Epidemic	Patient	Titer of neutralizing antibodies against			
		Lee virus +		PR8 Influenza ‡ virus	
		Acute	Convalescent	Acute	Convalescent
Irvington House 1940	Lee	0	120	120	100*
	Such.	0	90	35	60*
	My.	0	0	30	30*
	Dem.	0	30	60	60*
	Tren.	0	15	0	0
	Wo.	0	120	80	80
	Cast.	0	120	280	280
	Gouv.	0	240	280	280
No. Carolina 1940	Mar.	0	60	17 (0)	17 (0)
	Sp.	0	15	8 (0)	8 (0)
	Ha.	0	120	120 (30)	120 (30)
	Led.	0	60	30 (0)	30 (0)
	Mit.	0	15	15 (0)	15 (0)
	Dav.	0	30	25 (0)	25 (0)
	Kir.	15	0	15 (0)	4 (0)
Feb., 1936 (Unidentified)	Vr.	0	240	0	0
	B. Bas.	15	*240	50	50
1936–37 Influenza	Hum.	60	60	50	320
	Web.	30	50	0	35

+ Approximately 100 M.L.D. of Lee virus used.
‡ Approximately 100 M.L.D. of PR8 virus used. The sets of sera marked with asterisk or in parentheses were tested with 1000 M.L.D.
Endpoints estimated by the method of Reed and Muench.[3]

In January and February of 1940 an extensive epidemic of what appeared to be epidemic influenza extended throughout the southeastern portion of the United States. Through the kindness of Dr. D. T. Smith and members of the medical staff of Duke University Hospital, patients were made available for study. Since these investigations were undertaken toward the end of the epidemic, throat washings or sputum and serum taken during the acute and convalescent stages of illness were obtained from but 7 patients. Four of the throat washings were given intranasally to ferrets. In two instances serial passages through 4 ferrets were made. While some of the ferrets exhibited signs suggestive of infection with influenza virus, attempts to maintain the infection or to isolate a virus in mice were unsuccessful. The fourth passage ferrets (B45, B46) were bled on the 12th day; another (B32) on the 28th day. Their sera failed to neutralize the PR8 strain. Furthermore, when neutralization tests with the acute and convalescent sera of the patients were performed, using 100 and 1000 M.L.D. of the standard PR8 strain of epidemic influenza virus, no diagnostic rise in antibodies was detected. In this instance, again, the customary procedures had indicated that the virus of epidemic influenza was not involved.

[3] L. J. Reed and H. Muench, *Am. Jour. Hyg.*, 27: 493, 1938.

In view of the studies of the Irvington outbreak, the various sera were retested against 100 M.L.D. of the Lee virus. In 6 of the 7 patients a definite rise in titer of the convalescent serum was seen (Table II). Furthermore, serum of 3 ferrets receiving throat washings from these patients neutralized the Lee virus, although they had failed to neutralize the PR8 strain. In addition, serum from 6 ferrets inoculated by Dr. Horsfall with throat washings of patients from the North Carolina epidemic were tested. Four of them neutralized the Lee virus, all failed to neutralize 100 M.L.D. of the PR8 strain. The serum of 3 patients which had been found by Dr. Horsfall to show no increased convalescent titer against the PR8 strain, when tested against the Lee virus, exhibited marked rises in neutralizing antibodies. It is evident, therefore, that the Lee virus was the cause of the earlier general outbreak in North Carolina and adjoining areas.

In the early months of 1936 a widespread epidemic of acute, respiratory disease, indistinguishable from epidemic influenza, was studied. Its etiology was not established nor was any evidence obtained relating it to known strains of the virus of epidemic influenza.[4] Sera from 2 typical patients which had been kept in storage since that time were now tested against 100 M.L.D. of influenza (PR8) and Lee viruses. Pronounced rises of titer against Lee virus occurred but not against PR8 (Table II). It appears, in consequence, that this epidemic 4 years earlier was also due to virus of the Lee type.

Reference was then made to acute and convalescent sera of 2 individuals from whom epidemic influenza virus was isolated during the epidemic of the winter of 1936–37 (Table II). Titered against the PR8 strain, rises from 0 to 35 and 50 to 320 were noted; against 100 M.L.D. of the Lee strain the acute and convalescent titers of both were approximately 60. Hence, infection of human subjects with virus of the PR8 type does not result in a rise of antibodies to the Lee virus and the difference in etiology of the epidemics is further demonstrated.

Again through the kindness of Dr. Horsfall, serum of ferrets inoculated with throat washings of patients observed in the epidemic of influenza current in the West Indies this summer were tested. Certain of these sera also neutralized the Lee virus but not the PR8.

The immunological evidence indicates clearly that the newly isolated virus is the cause of the epidemics of acute respiratory disease in Irvington and North Carolina in 1940 and of the extensive epidemic early in 1936. These epidemics have presented no outstanding clinical features to differentiate them from the outbreaks which have yielded the virus of epidemic influenza, typified by the original WS and PR8 strains. The serological studies reveal, however, that they are etiologically distinct. In fact, the lack of cross reactions between serum against known strains of influenza virus and the present virus suggests that the latter is entirely unrelated to the virus of epidemic influenza previously isolated. Complement fixation tests which ordinarily detect the common antigen of different strains of epidemic influenza virus have not yielded up to the present any helpful information. Hyperimmune PR8 rabbit and ferret sera have not neutralized even small amounts of Lee virus. Furthermore, mice vaccinated with 2 intraperitoneal injections of 5 per cent. Lee virus have died of infection with 100 M.L.D. of PR8 but staunchly resist the same amount or more of the Lee virus. The differences are clearly greater than those detected in previous studies of strains of epidemic influenza virus.[5, 6, 7] The behavior of the virus in animals and the gross pathological features are, however, quite the same as those of mild strains of known influenza virus.

The usual experience has been that human subjects infected with one strain of influenza virus produce antibodies readily detected by tests with any of the ordinary strains obtained from man, or even with strains of swine influenza virus. The absence of antibodies to the Lee virus in the serum of patients at the time of their infection and the production of specific antibodies to that virus in convalescence are independent of antibodies to the PR8 strain which remain constant during the course of this disease. It is evident, therefore, that for the purposes of differential diagnosis, the Lee virus represents a serologically distinct entity. Nevertheless, the epidemic disease associated with virus of the Lee type appears on the basis of present knowledge to be as typical of epidemic influenza as that prevalent in outbreaks from which strains of the previously recognized virus were obtained. The epidemics of 1936–37 and 1938–39 have been shown to be caused by influenza virus of the usual variety while those of early 1936 and 1940 are of the Lee type. The two infections apparently possess independent cycles, but until further differential studies are made they should both be considered epidemic influenza caused by viruses of different serological types. The isolation of the new type of virus and the accompanying serological studies have established the etiology of epidemics of acute respiratory disease simulating influenza which had previously not been identified. Following the classification recently suggested[8] in which

[4] T. Francis, Jr., *Am. Jour. Pub. Health*, 27: 211, 1937.

[5] T. P. Magill and T. Francis, Jr., *Brit. Jour. Exp. Path.*, 19: 273, 1938.

[6] T. Francis, Jr., and T. P. Magill, *Ibid.*, p. 284.

[7] W. Smith and C. H. Andrewes, *Ibid.*, p. 293.

[8] F. L. Horsfall, Jr., E. H. Lennette, E. R. Rickard, C. H. Andrewes, W. Smith and C. H. Stuart-Harris, *Lancet*, 2: —, October 5, 1940.

the established form of epidemic influenza is called Influenza A, outbreaks caused by virus of the Lee type are to be designated Influenza B.

THOMAS FRANCIS, JR.
DEPARTMENT OF BACTERIOLOGY,
NEW YORK UNIVERSITY COLLEGE OF MEDICINE

THE VIBRATION OF CIRCULAR PLATES

THE equation for the nodal lines of a circular plate was worked out by Kirchhoff in 1850, having the form

$$w = J_n(kr)\cos(n\theta - \alpha) \qquad (1)$$

The first factor of this equation will give circles of different radii, while the second represents diameters. For nearly one hundred years this equation has been considered to be the most general possible solution so that the conclusion seemed inescapable that only circles and diameters could appear upon a circular plate. When plates are actually vibrated, however, many symmetrical patterns appear upon them which are certainly not circles. These variations from the theory were thought to be due to asymmetries in the plates, such as varying thickness, different tensions and so forth. If the assumption is made that a circular plate can give out two or more notes at the same time, then the equation of Kirchhoff may be extended in the form

$$w = AJ_n(kr)\cos n(\theta - \alpha_n) + BJ_m(k'r)\cos m(\theta - \alpha_m) \qquad (2)$$

When this equation is zero (the condition for nodal lines), the resulting figures are much more complicated than mere circles and diameters. It will be proved that they correspond to the figures produced by experiment.

In Fig. 1 are shown tracings from photographs of circular vibrating plates. The originals will be found in another article by one of the writers.[1] Below them in Fig. 2 are the mathematical curves resulting from

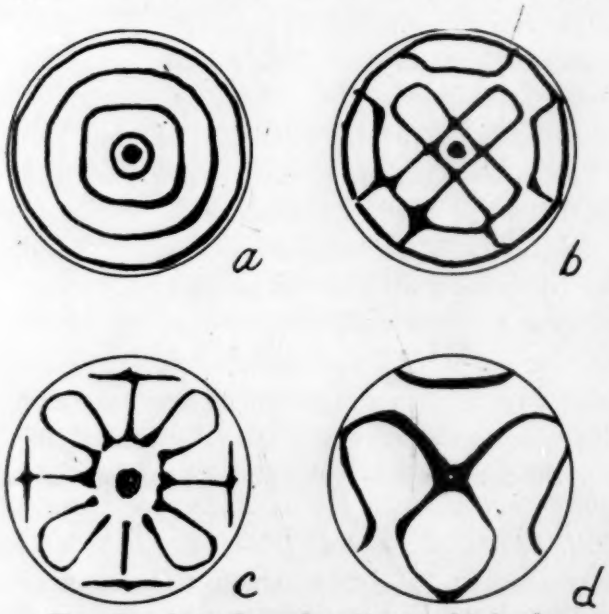

FIG. 1. Actual sand patterns obtained.

[1] Robert C. Colwell, *Jour. Franklin Inst.*, 213: 373–380, 1932.

substitution in Equation 2 of the proper numerical values. The exact equations for these are in order:

$$\left.\begin{aligned} 3J_0\left(\frac{12.53r}{a}\right) + J_4\left(\frac{11.95r}{a}\right)\cos 4\theta = 0 \quad (2a)\\ J_0\left(\frac{12.53r}{a}\right) + 2J_4\left(\frac{11.95r}{a}\right)\cos 4\theta = 0 \quad (2b)\\ J_2\left(\frac{5.937r}{a}\right)\sin 2\theta - 5J_6\left(\frac{11.00r}{a}\right)\sin(6\theta) = 0 \quad (2c)\\ J_2\left(\frac{5.937r}{a}\right)\cos 2\theta + J_3\left(\frac{3.497r}{a}\right)\cos 3\theta = 0 \quad (2d)\end{aligned}\right\} \quad (3)$$

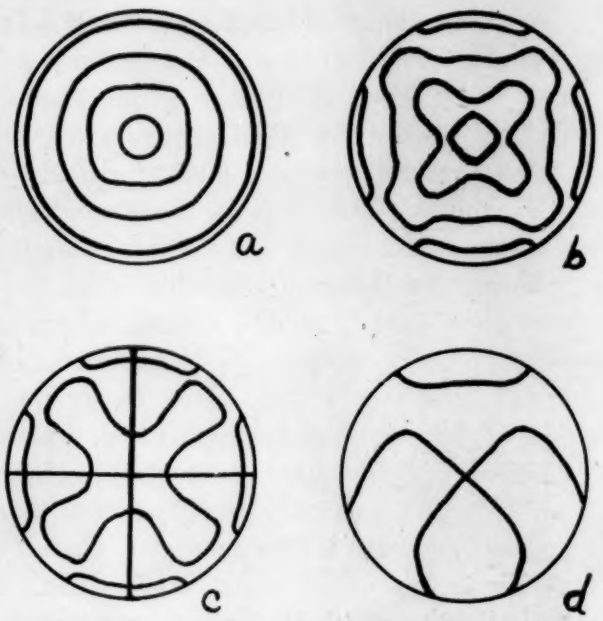

FIG. 2. Theoretical curves calculated.

The values of A and B are found by trial. After considerable experience one becomes more or less expert in picking out the number of circles and diameters in the Bessel and cosine functions which must be combined to produce any given figure. For instance, Fig. 2(*c*) is obtained as shown in Equation 3, for $A=1$, $B=-5$. If these ratios are changed, another equation appears whose plot resembles 2(*c*) but differs from it in some important details. In Fig. 3 are shown two curves obtained from the equations

$$\left.\begin{aligned} J_2\left(\frac{5.937r}{a}\right)\sin 2\theta - 10J_6\left(\frac{11.00r}{a}\right)\sin 6\theta = 0\\ J_2\left(\frac{5.937r}{a}\right)\sin 2\theta - 10J_6\left(\frac{11.00r}{a}\right)\sin(6\theta - 5^\circ) = 0\end{aligned}\right\} \quad (4)$$

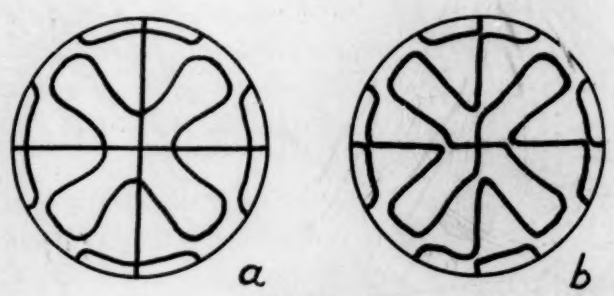

FIG. 3.

Simply varying the angle by 5° in Equation 4 causes the lines to split up. Both curves resemble that of Fig. 2(*c*) because similar functions are combined, although in different proportions.

Three functions may be added instead of two, or two functions may be multiplied together. The latter mathematical process indicates that two separate and distinct sets of lines may occur on a single plate at one time. Several such curves will be found in the last two pages of the article referred to above.

A fairly complete discussion of the method may be of interest whereby the mathematical curve of Fig. 2(*c*) is obtained from the Chladni plate shown in Fig. 1(*c*). To begin with it is usually best to take $A=B=1$; by doing this one is often able to recognize related configurations which previously had escaped notice. In the Chladni plate Fig. 1(*c*), there are seen six diameters and at least one circle. This reduces the total possibilities to a limited number, and it is finally found by trial that the two modes of vibration which produce this Chladni pattern correspond to one circle and six diameters combined with one circle and two diameters. Now the correct values of the *k*'s for these circles are found in tables of Bessel functions. From these the equation

$$AJ_6\left(\frac{11.00r}{a}\right)\cos 6\theta + BJ_2\left(\frac{5.937r}{a}\right)\cos 2\theta = 0 \qquad (5)$$

is obtained.

When this equation is plotted the two predominant diameters are on the 45° and 135° lines. These can be related to the 0° and 90° lines by changing the cosine to sine. This changes Equation 5 to

$$AJ_6\left(\frac{11.00r}{a}\right)\sin 6\theta + BJ_2\left(\frac{5.937r}{a}\right)\sin 2\theta = 0 \qquad (6)$$

This is the first equation of the two shown in Equation 4, in which $A=10$ and $B=-1$.

R. C. COLWELL
J. K. STEWART
H. D. ARNETT

WEST VIRGINIA UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR MEASURING AND RECORDING CONTINUOUSLY THE pH OF THE CIRCULATING BLOOD[1]

WITHIN recent years the glass electrode has been found readily adaptable to the continuous measurement and recording of the pH of the circulating blood in experimental animals. Of the more recent descriptions of a method of this type is that presented by Nims, Marshall and Burr.[2] Our report briefly describes a method similar in principle, but differing in details.

The units of the assembly employed consist of a chamber containing the glass electrode, a Cameron detector and pH meter, a potentiometer, a Leeds and Northrup mirror type galvanometer, a light source and a kymographic camera.

The essential features of the glass electrode assembly are shown in Fig. 1; during its use the ends of the severed blood vessel are attached to side inlet and outlet tubes, directly in case the vessel is large enough or by means of glass cannulae and rubber tubes. From the bottom of the chamber there is a recurved tubular extension to which there is attached a stiff rubber tube connecting with the KCl chamber containing the reference electrode. The electrode stem is held firmly in a tapered glass stopper which is ground to fit accurately the mouth of the chamber. The stopper is secured against arterial pressure by stopcock grease or rubber bands stretched between glass ears on both the stopper and chamber. The chamber with the electrode in place has a volume of approximately 1 cc.

For measuring the pH of the circulating blood the method of operation of the Cameron detector and meter is the same as that employed in the determination of the pH of any other fluid. The pH may be read directly from the dial; however, provision has been made for recording the electrode potentials by

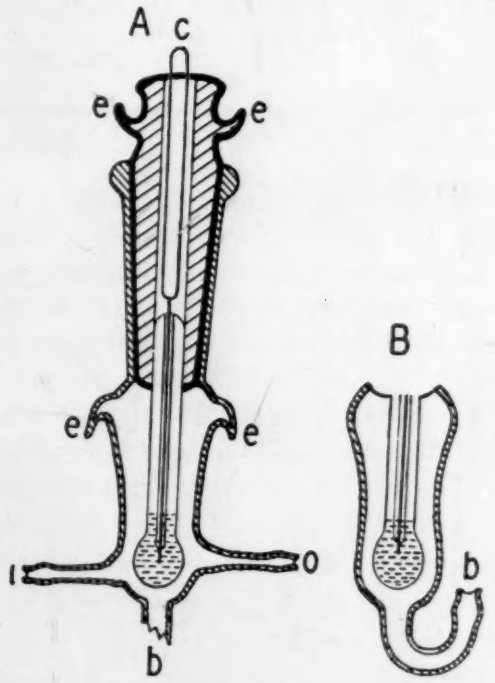

FIG. 1. A, cross section of the glass electrode and chamber, about two thirds natural size; b, position of salt bridge tube; c, wire contact; e–e, glass ears; i, inlet tube; o, outlet tube. B, cross section of the lower part of the chamber, showing the salt bridge tube more in detail. This tube lies in a plane at right angles to the planes of the inlet and outlet tubes.

[1] This work was aided by a Fluid Research Fund from the Rockefeller Foundation.

[2] Nims, Marshall and Burr, SCIENCE, 87: 197, 1938.

inserting a double-pole-double-throw switch into the circuit of the galvanometer within the instrument. In one position of the switch the circuit within the meter is unaltered, in a second position the galvanometer in the meter is disconnected and an outside galvanometer is substituted without disturbing the adjustment of the meter.

A Leeds and Northrup galvanometer unit (2420-c) with a plane mirror and mounted on a heavy wood base is used for recording. A narrow beam of light reflected from the mirror moves across the slit of the camera placed at a distance of one meter. A potentiometer, inserted between the pH meter and the recording galvanometer, is used to control the excursion of the light beam for a given unit change in pH. The calibration on the record is obtained by moving the pH dial through a given interval, usually 0.1 pH, and photographing the resulting excursion of the light beam.

For rendering the blood incoagulable heparin has been used in some instances; but we have also found Pontamine Fast Pink BL or Chlorazol Fast Pink B, 200 to 250 mgm per kilogram, satisfactory.

This apparatus is quite rugged and stabile. Continuous records of the pH of the circulating blood can be made with an accuracy of at least 0.01 pH, and with good approximation to the third decimal place. The type of record obtainable is shown in Fig. 2. This

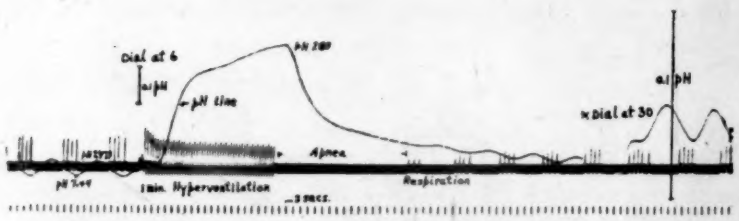

FIG. 2. A record of spontaneous breathing, hyperventilation, and the pH of the circulating arterial blood, obtained from a dog under barbital-sodium anesthesia. Dial readings refer to figures on the dial of the potentiometer between the meter and the recording galvanometer.

record was obtained from a dog under barbital-sodium anesthesia. The animal, as indicated, was hyperventilated for one minute. Prior to the hyperventilation, as well as after that procedure, the breathing was of the periodic type. The record shows, in addition to the marked rise in the pH of the arterial blood incident to the hyperventilation, a definite fluctuation in pH with each group of respirations. In a number of instances, in animals breathing slowly and deeply, we have observed and recorded measurable fluctuations in the pH of the circulating arterial blood coincident with each respiratory movement.

C. E. KING
EDMUND W. BENZ
VANDERBILT UNIVERSITY SCHOOL OF MEDICINE

A SIMPLE INEXPENSIVE DEVICE FOR ACCURATE DELIVERY OF SMALL AMOUNTS OF FLUID

To overcome the difficulties which are encountered when treating a large number of animals with small identical volumes of material, Dr. Robert T. Frank suggested that I devise an attachment for a tuberculin syringe which can be readily set and promptly made to deliver any desired amount of liquid. The device was not to interfere with quick assembly and cleaning.

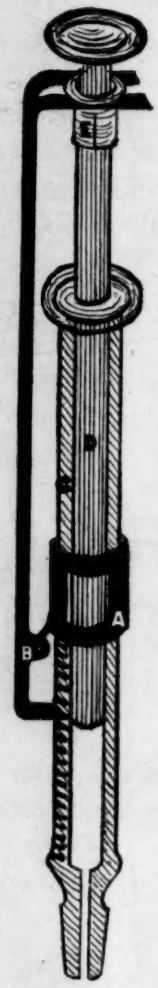

FIG. 1

The apparatus which has proved efficient consists of a spring clamp (A) encircling the barrel (C) with an arm (B) attached by a pivot. Both ends of this arm are bent at right angles. At the front end, facing the barrel, there is a sharp edge which engages the graduation lines etched into the barrel. The other end of the arm acts as a stop to the plunger (D) which carries a metal collar (E) with a flange to give a surface perpendicular to the stop. The amount delivered, when using this device, is as accurate as the graduation markings on the syringe. The device can be easily detached and applied to another syringe as required.

This device has been used with success by Dr. Robert T. Frank for injecting quantities as small as 0.02 cc.

JOSEPH VONDRAK
THE MOUNT SINAI HOSPITAL,
NEW YORK

BOOKS RECEIVED

CHANDLER, ASA C. *Introduction to Parasitology; with Special Reference to the Parasites of Man.* Sixth edition. Pp. xiii + 698. 309 figures. Wiley. $5.00.

CONN, H. J. *Biological Stains; A Handbook on the Nature and Uses of the Dyes Employed in the Biological Laboratory.* Pp. 308. Biotech Publications, Geneva, New York. $3.40.

FRANKLIN, PHILIP. *A Treatise on Advanced Calculus.* Pp. xiv + 593. Wiley. $6.00.

HARROW, BENJAMIN. *Laboratory Manual of Biochemistry.* Pp. v + 119. 19 figures. Saunders. $1.50.

HEHRE, FREDERICK W. and GEORGE T. HARNESS. *Electric Circuits and Machinery. Vol. I, Direct Currents.* Pp. ix + 513. Illustrated. Wiley. $4.50.

MACDUFFEE, CYRUS C. *An Introduction to Abstract Algebra.* Pp. vii + 303. Wiley. $4.00.

POTTER, GEORGE E. *Essentials of Zoology.* Pp. 526. 204 figures. Mosby. $3.75.

TIMBIE, WILLIAM H. and VANNEVAR BUSH. *Principles of Electrical Engineering.* Third edition. Pp. ix + 540. 388 figures. Wiley. $4.50.

TRANSEAU, E. N., H. C. SAMPSON and L. H. TIFFANY. *Text-book of Botany.* Pp. xi + 812. 424 figures. Harper. $4.00.

WHITE, E. GRACE. *Principles of Genetics.* Pp. 352. 179 figures. Mosby. $2.50.